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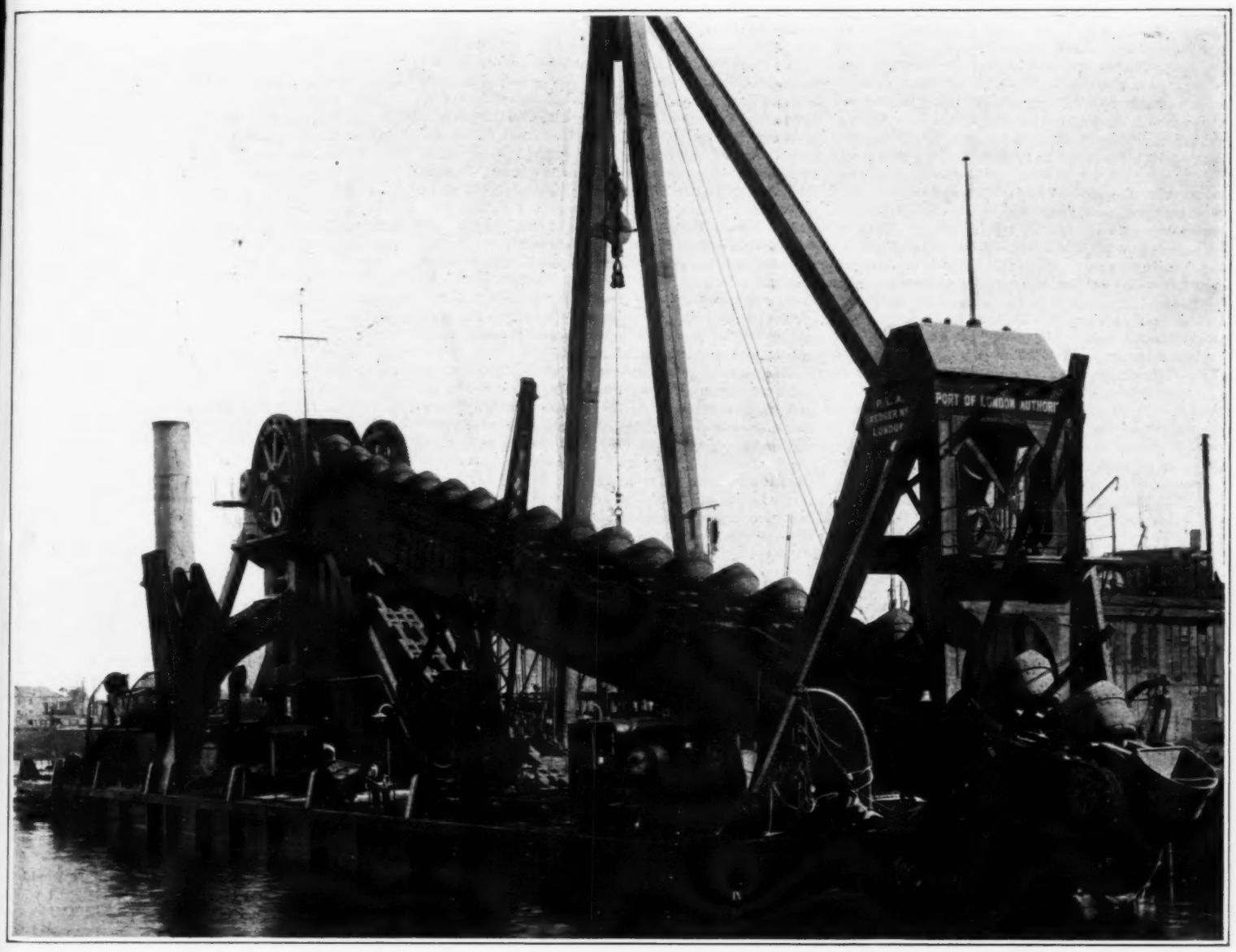


Fig. 1.—The Largest Bucket Dredger on the Thames River.

Fig. 2.—The Port of London Bucket Dredger at Work.

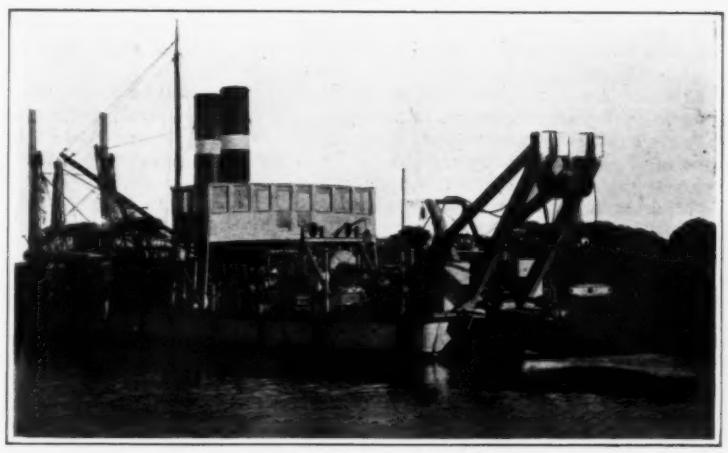

Fig. 3.—A Modern Suction Dredger Showing Clay Cutter at the Right.

MODERN DREDGERS OF THE BUCKET AND SUCTION TYPES.—[See page 403.]

# Fuel as a Factor in Locomotive Capacity*

## The Hardest Worked of all Types of Steam Plant

THE power developed by a steam locomotive is derived from the fuel it consumes. Other things being equal, the greater its rate of fuel consumption the greater will be its capacity. Success in the development of this problem long ago characterized the locomotive as the hardest worked of all types of steam plants. This characterization is based upon the fact that the draft which urges the locomotive fire is unusually strong, its value as measured by a draft gage under normal operating conditions ranging from 5 to 12 inches of water; that this strong draft results in the burning of from 100 to 200 pounds of coal for each foot of grate per hour, and a rate of evaporation which may exceed 16 pounds of water per foot of heating surface per hour.

The draft, the rate of combustion, and the rate of evaporation are matters which have been subject to little change during the last quarter of a century, but the demand for increase of power has been present throughout this period. The demand has been met by increasing the dimensions of the locomotive. Boilers and cylinders have gradually been made larger, and all the details of mechanism have been designed to control and transmit the increase in power for which these changes have provided. The result is the modern locomotive; a machine of unprecedented power, a complete steam-power plant which, as represented by a recent design, is capable of developing a horse-power for each 121.4 pounds weight.

But the weight of the modern locomotive cannot be greatly exceeded except at the expense of extensive improvements in track or through the adoption of an arrangement of wheels which will permit the load to be much more widely distributed than at present. As it is not likely that the demand for higher power will cease, the problem of supplying it is one of more than academic significance. It presents two possible lines of solution, both of which are of especial interest to the members of this association. One possible line of development is through the better adaptation of fuel to the needs of locomotive service, and the other is through the better adaptation of the locomotive to the requirements of the fuel which it has to burn. It is my purpose to discuss briefly the possibilities of increasing locomotive power by attention given to each of these lines of development.

Anything which will successfully promote the combustion of fuel in the firebox of a locomotive will at the limit operate to increase its power. Every pound of coal effectively burned represents a definite output in the form of power at the drawbar, and if through care in the choice and preparation of the fuel the rate of combustion can be materially increased, it is evident that the maximum capacity of a locomotive may be advanced. This fact is lost sight of when locomotives performing service, in which maintenance of schedule is a matter of great importance, are supplied with coal that is bad in its composition and which is a mixture of the finest dust with lumps of every possible size. Conditions of service which demand high power will justify unusual care in the selection of fuels. The coal used under such conditions should have a high thermal value, and it should be low in clinker and ash. It should be sized before it is put upon the locomotive tender and if necessary it should be washed and sized. One who looks upon sized coal in a car and then upon a carload of run of mine coal and considers that on the grate the combustion of coal can only proceed as air can pass through the bed and around the individual particles of coal, will easily understand the superior advantages offered by the sized fuel. A principal advantage of the briquetted fuel so much used in foreign railroad practice is to be found in the fact that the briquettes are of uniform size. When the coal fire is made up of pieces of uniform size, it forms a bed on the grate in which the interstices between the pieces of coal are uniform and the admission of air over the entire area of the grate is in finely divided and uniformly distributed stream. The result is that every part of the fire is maintained in a condition of maximum efficiency, the temperature of the firebox will be higher than when mixtures of lumps and fine coal are fired; the rate of combustion will be greater, and, as a consequence, the capacity of the locomotive will be increased.

The power of a locomotive cannot be increased indefinitely merely through the proper selection of fuel, but the limits of its maximum performance may be materially extended. Through care in the selection of fuel a small locomotive may be made to perform the service of a larger one, a saturated steam locomotive may be made to perform the service of a superheating locomotive of the same class, and a large locomotive may have its power limit materially increased. There are no objections to the general introduction of especially prepared fuel for locomotives excepting those of cost. The fuel bill of the railroads is already an enormous one, and those who are responsible will always hesitate before permitting an increase in the purchase price per ton. But the ultimate cost, when measured in terms of service given, will be found in many cases justifiable. Under present practice, railroads in their desire for some increase in power, do not hesitate to increase the weight of their locomotives by giving them larger boilers, by raising their steam pressure, by the adoption of compound cylinders, and by the addition of superheaters. All of these are expensive measures, but they have been justified in practice by the results obtained. The more careful preparation of fuel is to be looked upon as a means to an end. It constitutes an embellishment in locomotive operation and is not different in purpose from embellishments in design. It will add to the expense, but will give a return in increased power which at the head of important trains may be greatly needed for the maintenance of service. I believe that a great opportunity, which as yet has been but little appreciated, lies awaiting the attention of the prophet who will proclaim the gospel of increased power of locomotives through the more careful selection of their fuels. The time is at hand when lump coal will be washed and sized, and when the fine coals will be briquetted.

The alternative plan whereby the power of the locomotive may be increased, is that which provides for a development of its design along lines which will give it greater capacity to consume the indifferent fuels which under present practice are commonly supplied it. What changes need be made in the present practice to provide a greater fuel-burning capacity? The first requisite in the development of such a design is a large grate. The fact is recognized that grate areas have increased enormously during the last twenty-five years, that whereas their area used to be less than 20 square feet, they now have an area which is often more than 70 square feet. If a design could now be made which would permit the present maximum grate area to be doubled, several important results would at once be secured. First, while the total amount of fuel burned per unit of time might be materially increased, the rates of combustion per unit area need not be increased, it could be reduced. The increase of power would be proportional to the increase in the total fuel burned, while the reduced rate of combustion would avoid the necessity for special care in the selection of fuel, would allow the use of fuels now normal to locomotive service; would operate greatly to reduce the loss of fuel in sparks, and would prolong the period during which the locomotive could be kept in continuous operation.

For example, when 6,000 pounds of coal are burned per hour on a 60-foot grate, the rate of combustion is 100 pounds per foot of grate per hour and the spark loss with many fuels represents fuel values which approach 10 per cent of the coal fired. The collection of ash and clinker on the grate so much impedes the draft as to require a thorough cleaning of the fire after a run in passenger service of from 100 to 150 miles. A greater distance, if attempted, must generally be run at reduced power. With a larger grate these conditions are all changed. The burning of 6,000 pounds of coal on a 120-foot grate would reduce the rate of combustion to 50 pounds per foot of grate per hour, and the spark loss to 2 or 3 per cent, and would permit continuous operation for a passenger run of 300 miles between the cleaning of fires. It is true that the larger grate would be at some disadvantage with reference to losses in the form of fuel left on the grate at the end of the run, and in the larger amount required to cover the grate in the process of starting fires; but these would be entirely neutralized by the possibility of increased mileage between the starting of new fires. With the larger grate, only half as many new fires would need to be made per thousand miles run as were formerly required. When the same total amount of coal is burned in each case, it is evident that the 8 per cent saving in spark losses would at once be made available as an 8 per cent increase of power; also that among the possible variations in the method of taking advantage of the presence of the larger grate will be included the possibility of increasing the rate of combustion. For example, an increase in the total fuel consumed from 6,000 to 8,000 pounds an hour, would increase the power capacity of the locomotive by 33 per cent and would involve rates of combustion which judged by present-day standards in locomotive service would be accounted low. If the rate of combustion were forced to a total of 10,000 pounds, the increase of power would be 66 per cent and the rate per unit of grate area would still be below the maximum now common in locomotive service. There is, therefore, much to be accomplished by increasing the grate area of a locomotive. If the output of power remains unchanged, it will permit lower rates of combustion, a reduction of spark loss, and the use of inferior grades of fuel. If, on the other hand, the rate of combustion per unit area of grate remains unchanged, the output of power may be increased in proportion to the increase in the area of the grate.

Locomotive grates having an area of 150 feet or more would necessarily involve some new departures in locomotive design. As the width of such a grate could not greatly exceed 7 feet, its length would need to be from 20 to 25 feet. This may mean a complete abandonment of the existing type of locomotive boiler and the substitution therefor of some new type, but it does not necessarily imply such a change. It does mean, however, the adoption of an articulate form of locomotive which will admit of a space of 25 feet or more between the two systems of wheels. It should be possible either to increase the spacing of the frames over this space or to drop the frames so low that the firebox and boiler with attachments may have an unobstructed area the full width of the track clearance for all heights 3 or 4 feet above the rail of the track.

In working out details, automatic stoking must be provided for. This can best be done by having the stokers feed transversely across the boiler from both sides of the firebox. The stokers themselves may be either of the chain belt or of the Roney type, or they may consist of any simple feeding mechanism, delivering to fixed inclined grates. They would be very short in the direction of the fuel movement, probably not more than 30 or 32 inches in length, and they would discharge on a flat dump grate running the whole length from front to rear of the firebox. The aggregate width of the individual stokers on each side would, of course, be from 20 to 25 feet, but they would be split up into as many different units as would best provide for the construction of short arches over them. By such an arrangement, the green coal would pass under the mudring of the boiler and under a short arch, where it would ignite. It would gradually be pushed forward toward the center of the firebox to the flat dump grate, where it would be met by fuel coming in from the other side. The inward movement of coal from both sides toward the center of the grate would, of course, proceed throughout the full length of the firebox, that is, for a distance which might be as great as 25 feet. The fact that the ignition of the fuel would be under an arch would make the combustion nearly or quite smokeless, the mild draft would make the cinder losses small, while the low rate of combustion per unit area of grate, and the provisions for cleaning supplied by the stokers and dump grate, would permit continuous operation at full power for a very long period.

Narrow hoppers supplying these stokers would open up along the whole length of the firebox on both sides to the full width allowed by the track clearances. The operating mechanism of the stokers, which would be beneath them, would be allowed the same total width. An extension of these hoppers upward on both sides to the level of the top of the boiler or higher, would provide space for all the coal necessary for a run. No coal would be carried on the locomotive tender and none would need to be rehandled on the locomotive. It would all be loaded at once into an extension of the stoker hopper, and its weight would be added to the wheel loads of the locomotive.

In the discussions of the preceding paragraph, I have assumed that the general type of boiler employed would not be materially different from that now in service. Difficulties would, of course, appear in the construction and maintenance of a stay-bolt firebox 25 feet in length, and whatever the outside form of the boiler might be, some special provision would need to be made in the working out of its construction. A demand for a firebox of such dimensions would doubtless call out various means for supplying it. There would probably be no difficulty in constructing a Jacobs-Shupert firebox of any desired length. The boiler would be so located on the frames of the locomotive that its back-end would be just in advance of the first of the rear system of driving wheels, and a foot-plate carrying all of the auxiliary machinery of the locomotive would extend rearward over the axles of these rear wheels and perhaps over the wheels themselves. A fire door would enable the fireman to inspect his fire, and so to control the stokers as to maintain uniform conditions throughout the grate. The barrel end of the boiler would extend out over the forward wheels.

*Paper read before the International Railway Fuel Association by Dr. W. F. M. Goss, dean and director of the College of Engineering, University of Illinois, Urbana, Ill. Published in the *Railway and Engineering Review*.

# Painless Surgery*

## One of the Greatest Gifts of Modern Science to Humanity

**By Dr. Dittman**

FROM the earliest times of primitive surgery the effort has been constantly made to reduce the dangers and terrors of operative treatment to a minimum. In the days of Roman civilization surgeons had learned to control bleeding by ligaturing blood vessels, but the worst enemy—septic infection of the wound—has been successfully conquered only within the last fifty years or so. And the painless method of surgery dates but a few years farther back.

In our days of "painless dentistry" it is difficult to realize the terrors which surgical operations held for the patient in the old days. It is true that opium and Indian hemp were employed internally as palliatives, but these could at best fulfill their purpose only very imperfectly. In the middle ages the vapor of hemlock or mandrake were often administered to the patient, or occasionally he was severely bled, to fainting, with a view to reducing the pain. Such measures must, however, have been attended with little success. We hear also of occasional attempts to operate under hypnotic influence—but such a method could be only of limited applicability.

Thus the development of anæsthesia in surgical work is essentially a product of the nineteenth century. The first anæsthetic to be used was nitrous oxide, or so-called laughing gas, the narcotic action of which was known as early as 1800, though it did not find extended application until 1844, when the American dentist, Horace Wells, introduced it into practise. Laughing gas has not, however, proved well adapted for major operations, and its use has not become very general, two other anæsthetics, ether and chloroform, introduced shortly after, having been found much superior for general purposes. The first use of ether in surgery must be credited to the American surgeon, Long, and dates from 1842. Long, however, failed to give publicity to his discovery, and for this reason the Boston dentist, Morton, is often mentioned as the originator of the use of ether. In 1846 another American, Warren, performed a number of major operations under ether, and from this point on the use of this anæsthetic spread triumphant over the whole earth.

About the same time, 1847, the English surgeon, Simpson, made the first report on the use of chloroform for anæsthesia. It seemed at first as if this were superior to ether, but presently warning voices were raised that its use was attended with certain dangers.[1] To this day it is a disputed point which of the two substances is preferable. Each has its advocates, as each possesses certain advantages. One drawback about ether is its extreme inflammability; it is also somewhat objectionable owing to a certain irritating action upon the mucous membranes of the respiratory passages, and its stimulation of the secretion of saliva. On the other hand, chloroform is apt to have an evil influence upon the heart.

Among other anæsthetics which have been suggested may be mentioned methyl bromide, which is still occasionally used for minor operations. It gives complete, though transient anæsthesia in one or two minutes. It has the advantage of leaving no unpleasant after effects, such as nausea.

Every narcosis is a case of transient poisoning, comparable with alcoholic intoxication, and is accompained by the paralysis of certain groups of nerve cells of the brain and spinal cord. This paralysis must be allowed to proceed to a certain definite stage, such that on the one hand all sensation is lost, while on the other the vital centers controlling heart action and respiration are left unaffected. Between these two limits is comprised a somewhat narrowly defined zone, a state of "half-life," the maintenance of which demands great skill and careful attention on the part of the physician. Every patient should therefore be subjected to a careful examination before the anæsthetic is administered, to determine the presence of any possible lesion of heart, lungs or kidneys, which would render the use of the anæsthetic dangerous.

The first effect, occurring about a minute after inhalation is started, is a transitory loss of consciousness; this can be made use of for comparatively trivial operations, such as the setting of a dislocated joint. Generally it is necessary to proceed further, through a stage of partially returning consciousness, often attended with a certain agitation, in which the patient may talk and gesticulate incoherently, or may seek to rise from the operating table. Persons addicted to drink are apt to be particularly boisterous; women give less trouble, and children practically none.

An excellent diagnostic indication of the depth of the anæsthesia is furnished by the reflexes of the eye. As everybody knows the eye closes involuntarily at the lightest touch of the cornea or often even of an eyelash. This reflex persist during the earlier stages of anæsthesia. When these reflexes are paralyzed, so that the eye no longer responds to a touch, the operation can be begun, and the physician who administers the anæsthetic must confine his entire attention to the maintenance of this condition, so that on the one hand the operating surgeon shall not by any chance be disturbed by reactions to pain on the part of the patient, while on the other hand, of course, the inhalation of a dangerous excess of the drug must be avoided.

In the course of the many millions of operations which have been performed under an anæsthetic, naturally many improvements have been introduced. Perhaps the most important of these is the use of a mixture of ether and chloroform in adjustable proportion. In this way it is possible to combine to some extent the advantages of the two narcotics. The method is closely associated with the name of the celebrated surgeon Billroth. Recently diluted ether has also been administered by intravenous injection, with great advantage, it is claimed. Another innovation is the subcutaneous injection of a small dose of morphine and scopolamine about one hour before the operation, when anæsthesia can be induced with a greatly reduced amount of chloroform or ether. This process is said to be practically free from danger.

Within the last ten or twenty years general anæsthesia has found an important competitor in local anæsthesia. This is quite free from danger and the unpleasant secondary effects are eliminated. As early as 1866 Richardson used an ether spray to locally deaden sensibilities by its refrigerating action. At the present time ethyl chloride is more generally used for this purpose. Much more effective as a local anæsthetic is cocaine, administered in the form of solution in normal salt solution. This agent has been known since 1860, but remained in comparative obscurity till 1884, when it was first extensively introduced for surgical treatment of the eyes. In this case the solution is merely dropped into the eye, when it produces its effect. It is similarly applicable directly in the treatment of the mucous membranes of the nose and throat, where its use is attended by the additional advantage that it produces a local anemia (blood lenses) and contraction of the tissues, which greatly facilitates surgical procedure.

This method of merely "painting on" the solution is, however, not applicable to the ordinary skin. Here hypodermic injection is necessary. The addition of adrenalin or similar drugs to the cocaine in this connection has been found exceedingly advantageous.

There are two modes of applying cocaine. On the one hand the tissues themselves, which are to be subjected to surgical treatment, may be saturated with the drug; or the latter may be brought to bear upon the nerve trunks supplying the part in question. According to a process introduced by Dr. Bier the drug is injected into a vein, after expelling the blood from the part to be operated, and applying a tourniquet. The same surgeon is the originator of the spinal anæsthesia which has attracted a good deal of attention of recent years. In this case tropococaine or stovaine are injected into the space below the end of the spinal cord, between the second and third lumbar vertebræ. The entire lower half of the body is thus rendered insensible, and serious operations can be performed upon patients who would be unable to submit to general anæsthesia.

*Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from RECLAMS UNIVERSUM.

[1] An avoidable source of danger in the use of chloroform is the presence of certain poisonous impurities.—ED.

# Modern Dredgers of the Bucket and Suction Type

**By F. C. Perkins**

THERE are two principal types of dredgers used at the present time in addition to the steam shovel design, one of which is the bucket dredger, which is particularly valuable for certain classes of work where the suction dredger cannot be utilized to advantage. The latter, equipped with a clay cutter, may, however, be operated successfully for work which is not well adapted to the bucket dredger and is particularly desirable for handling sand, gravel and clay, which may be pumped to considerable distances without difficulty.

In the front page halftones, Fig. 1, shows a large bucket dredger of the Lobnitz type on the Thames River, as constructed at Renfrew, Scotland, while illustration Fig. 2 shows the dredger of the Port of London at work. This bucket dredger has a hull measuring 214 feet in length by 40 feet in width with a depth of 12 feet 6 inches. Its dredging depth is 55 feet below water level and the capacity of the buckets is 27 cubic feet each. It is fitted with a triple expansion engine of 600 indicated horse-power supplied with steam from two large marine, return tube boilers. There is a powerful winch provided for raising and lowering the bucket ladder, and also three large mooring winches arranged for working mooring chains 2 inches in diameter.

Illustrating the modern Scotch dredge, the clay cutter "Simson," seen in the occompanying photograph, Fig. 3, is an excellent example. It is arranged with a suction pipe in a central well, carrying a clay cutter for working to a depth of about 45 feet below water, but the piping arrangement can also be changed for working as a large unloading dredger.

The vessel has the following dimensions: Length, 150 feet; width, 33 feet; depth at the ship's sides, 12½ feet. The mean draft in working order is 6½ feet.

For supplying the necessary power two triple-expansion engines of 500 indicated horse-power each are provided, each actuating a powerful sand pump. These pumps can be arranged in parallel or in series, according to the distance to which the stuff is to be pumped. In addition to these two engines there is one triple expansion engine of 200 indicated horse-power driving a centrifugal water pump to be used when the dredge is used for emptying barges.

The cutter-engine driving the clay-cutter develops 200 indicated horse-power. There is installed on this dredge a complete self-contained condensing plant, consisting of a surface condenser and a set of compound horizontal engines driving all the necessary pumps. It takes the steam from all the above named main engines and also from the auxiliary engines, pumps, winches and dynamo engine sets.

The handling of the dredge is absolutely centralized. It works on two studs and two side lines operated from one big four-barrel winch with heavy friction clutches and hand brakes.

The ladder is hung from a separate steam winch. All handles for clutches, brakes, reverse gear and steam valves of these two winches are brought together in the pilot house, in which are also located the handwheels and levers for manipulating the cutter engine. There is also in view of the operator a complete set of pressure and vacuum gages for boilers and engines as well as the suction and delivery sand pumps.

From the pilot house one man can easily work the whole dredge. There are two marine boilers supplying steam to the engines having a total heating surface of 4,300 square feet. They produce the necessary steam at a working pressure of 160 pounds per square inch.

This machine can dig and force ashore fully 75,000 cubic yards of sand, gravel or clay per week as shown by test in actual service.

**Diabetes and Life Insurance.**—In a recent number of *Die Umschau* Dr. Feilchenfeld discusses the eligibility of diabetic persons for life insurance. Statistics show that in mild cases the life prospects are very favorable, and that such a patient represents a good risk, and may be expected to live ten or fifteen years or longer. However, cases showing hereditary predisposition, or complications of any kind, must be excluded.

# The German Patent System*

By Herbert F. Wertheimer

THE laws regulating the protection of intellectual property in the German Empire are of relatively recent date. Previous to 1870, some of the many Kingdoms and petty States, forming now the modern German Empire, had special laws to that effect. However, all these laws proved to be rather ineffective in view of the relatively small extent of each individual State. Only the peace of Frankfurt, which established the national unity of Germany, removed this condition of affairs, which had for so many years handicapped technical and scientific progress in Germany. The new constitution expressly provides that the protection of industrial property is under the jurisdiction of the Empire. Since then, a series of broader laws has come into force, among which the patent law is undoubtedly the most important one. This law has had a predominant influence upon the unprecedented rapid development and high standard of German industries. The number of native and foreign inventors applying for patents, increases from year to year; it is a noteworthy fact that among foreign applicants, *American inventors predominate*. It may, therefore, not be without interest, for Americans, to know the broad outlines of the principles and rules of practice and procedure of the German Patent Law.

*In Germany, a patent is regarded to be equivalent to a promotion of national knowledge by the disclosure of a heretofore unknown art. The inventor is judged to be a kind of teacher to the nation. Therefore, the Patent Office does in no way care for the real father of an invention. To the first applicant is allowed the patent, and lack of first and true inventorship does not invalidate or bar the grant of a patent unless the invention has been fraudulently obtained, or stolen.* If in this case, the person from whom it was stolen files an opposition at the proper time, or starts an annulling suit against the granted patent, the patent is refused or annulled. Moreover, under certain conditions, a fraudulent patentee may be compelled, by a lawsuit, to assign the patent, or even the patent application to the original owner.

This broad principle regulates easily the status of persons who have actually carried out the invention previous to a patent application by another, as well as the question of interfering applications. Such persons are not affected by the patent, for they have not been instructed by the inventor; in other words, they have not derived any new or useful knowledge by the disclosure of the patent. Therefore, they have a legal right to use the patent for their own business, but this right can only be assigned to others together with the transfer of their whole business. In other terms, they are entitled to a limited free license. Patents filed later on for the same subject matter, for which a former application was filed, are simply refused, if the earlier application results in a patent. So all the interfering applications are rejected in favor of the first applicant, even if they are based on inventions that have been conceived at an earlier date. This, of course, stimulates inventors to apply for a patent without delay, and gives the public the benefit of early disclosure; it excludes expensive and complicated interference proceedings, and prevents applications from being kept pending in the office, for endless years, as frequently happens in the United States. It, furthermore, prevents anybody engaged in a business which is based or not on patents, being threatened at any time with unexpected destruction of business, on account of some hidden or creeping patent applications which, several years later, develop interference proceedings.

Every application for a patent is examined by an examiner just as in the United States, and substantially along the same lines; on the average, the requirements as to inventive quality are more rigid. If an application is in the proper shape, and patentable according to the examiner's opinion, he forwards it to a Board of Examiners for a preliminary decision. If the Board of Examiners, which is composed of at least three examiners, judges that the invention is not patentable, they reject the application, in about the same way as in the United States. Otherwise, they issue the so-called decision of publication; that is to say, they apply for a supplementary public examination by publishing the title, filing date, name and residence of the applicant in the *Reichsanzeiger*, or official journal. Numerous technical periodicals reprint this publication for their readers, and thereby inform the public that the Patent Office is about to grant a patent on the published invention.

At the same time, the drawings, models, specification, and claims are rendered available to public inspection for a period of two months. During that time, anybody can file a written opposition against the grant of a patent. In this way, the inventor, as well as the public, is guarded against the issue of invalid patents. Anybody, in any part of the world can file such an opposition without any costs. The law prescribes only that the opposition be filed in the German language and before two months and that it embody the necessary argument. In this way, no individual who can show that the grant of the patent is unjustified is withheld from formulating his arguments, unhampered by any other formality than the mere writing and stating of the argument—all this without the necessity of passing through the intermediary of an attorney. Opponents who file their opposition too late are not considered in the further proceedings, though their information may be given consideration by the examiners in their final decision.

If no opposition has been filed within a two months' period, the Board of Examiners issues a second decision by which the patent is finally granted; thereupon the specification is printed and published, just as in the United States.

If an opposition has been filed in due time, the opponent thereby becomes a party of the further legal proceedings. He gets information of all the arguments of the applicant and, *vice versa*, the applicant is kept informed of all opposition arguments and the names of his opponents; after the situation has been cleared up, the Board of Examiners decides whether or not the opposition was justified and whether the patent shall be allowed as presented, or allowed with restricted claims, or refused entirely.

During the whole period of examination, up to the final grant of the patent, the Patent Office can, if it deems it necessary, hear witnesses. However, all testimony is taken by the office itself, or if the witnesses live at distant points, by the courts of justice in that district, at the request of the Patent Office, which prearranges and formulates all the questions to be put before the witnesses. No opponent or applicant can be a witness in his own behalf, nor has he any influence upon the decision of the office, and the latter alone decides what witnesses shall be heard and which not. All these questions are decided by the Board of Examiners as far as the interests of the applicant and the public may require, and no appeal is admitted against such a decision. Furthermore, no costs can be charged by the Patent Office for taking testimony, even if such testimony has to be taken in German colonies or in foreign lands, under the provision of the Convention of The Hague. Taking testimony by lawyers as in the United States, in the presence of a notary public, is unknown in Germany, and depositions of witnesses that are obtained in this way would be without any consideration whatever before the German courts.

This same way of taking testimony is followed in all proceedings whether they be for annulment, for compulsory license, or for revocation.

If the grant or rejection of a patent has been agreed upon by the Board of Examiners, every applicant or opponent who feels himself injured by that decision can still file an appeal to the Board of Appeals, composed of five officials. The Chairman of this Board of Appeals is the Commissioner of Patents, or the so-called "Praesident," or in his absence, one of his legal representatives. The Board of Appeals re-examines the whole case and its decision is final.

The life of a patent in Germany is fifteen years, which begins with the day succeeding the filing day. The protection it confers becomes effective on the day of publications of the invention in the *Reichsanzeigers;* from that day on, the inventor can sue infringers, or the public can start a suit for a compulsory license against the inventor. It is obvious that the effective life of a German patent is therefore always shorter than fifteen years, and can be badly shortened by any retardation in the issue of the final decision of allowance. In average, if no opposition is filed, and no other complications are met, about two years are absorbed, until the patent is finally granted. This represents one of the most serious defects of the German patent system, but very probably the next revision of the patent law which can be expected in 1914 will remove this deficiency.

The maintenance of patent rights depends, furthermore, upon the payment of certain yearly taxes, small during the first years, but increasing from year to year, and upon the non-payment of which the patent lapses without possibility of reinstatement. A patent lapses at once if patentee renounces it by written declaration.

Other persons can remove a patent right only by a suit for annulment or for revocation; such suits are brought before the Annulment Board of the Patent Office. This provision represents one of the predominant differences over the American system, inasmuch as no court is entitled to discuss the validity of a patent, as long as the patent has not been annulled by the same Patent Office by which it was granted; the courts have to take the patent as it stands and it is only left to them to interpret it in a broad or narrow sense, if the scope of the claims is unclear.

Fraudulent possession of an invention is always a reason for annulling a patent, if the annulment suit is started by the injured party; suits for annulment on account of lack of invention can only be instituted within the period of five years after publication of the final grant of a patent in the *Reichsanzeiger*. After expiration of this term, the patent stands valid and unassailable. Probably this latter provision will be canceled before long, inasmuch as it has caused many inconveniences and injustices to the public.

Appeals against the decisions of the Annulment Board are not decided by the Board of Appeal, but by the highest court in Germany, the Reichsgericht in Leipzig. In all the legal decisions in patent matters, the "President" of the Patent Office has no other intervention than to act as the Chairman of the Board of Appeals and of the Annulment Board. He is never chairman of the Board of Examiners, and his other official functions are more of an administrative character, at least as far as patent matters are concerned.

Apart from annulment suits, the Annulment Board and the Reichsgericht decide all the actions for the grant, of a compulsory license, or the revocation of patents. Up to May 1st, 1911, a patent could be revoked if it were not worked in Germany, or if, in spite of the offer of reasonable royalties and deposit of a guarantee, the patentee refused the grant of a license, provided such a grant were advisable for the public interest. Influenced by the introduction of the new revocation practice in England, and since a decision of the Reichsgericht in a revocation suit against an American patentee, it was held by the court that by reason of the German-American treaty of February 23rd, 1909, no American could be compelled to work his patents at all in Germany; it even was decided, if the patent was assigned to an American after the revocation suit had been started, these compulsory working provisions did not apply to him.

Under later provisions, Germany has no longer compulsory working of patents, to whatever nationality the patentee may belong. But any patentee can be compelled by decision of the Annulment Board to grant a license in exchange of payment of reasonable royalties, and deposit of a guarantee, provided such a compulsory license is conducive to the public welfare, all this regardless of the actual working or non-working of the patent by the patentee or other persons. However, it has not yet been decided, and it is doubtful whether, in view of the above-mentioned American treaty, patents which are owned by Americans are met by the new provisions of the law. Revocation of patents on account of non-working is now possible only if the patent is worked exclusively outside of Germany, but even then this does not seem to affect American patentees on account of the existing treaty.

As the courts are not allowed to discuss the validity of patents, a suit against infringers is relatively simple. Unintentional or careless infringers can be sued for damage, but intentional infringers are moreover liable to fine and imprisonment on motion of the patentee or his representatives to the public prosecutor (Staatsanwalt). Preliminary and final injunctions can be issued, or an infringer can be sued first so as to compel him to acknowledge that he actually infringes a patent. On the other hand, a similar acknowledgment suit can, under certain conditions, be started against the patentee, so as to compel the latter to acknowledge non-existence of infringement by another party. The defeated party has to pay the expenses and costs of the winning party. All these infringement suits are decided in open court before civil courts. Upon appeal, they are finally decided by the Reichsgericht, so that practically all the questions of predominant importance are decided by one and the same court. Infringement suits are relatively rare, and by no means so frequent as in the United States. Furthermore, they are considerably less expensive. The time consumed for reaching a final decision in an infringement suit depends, of course, largely upon the complications of the subject matter, the necessity of making experiments, etc. Most of the courts in industrial districts in Germany have special departments to which are assigned all cases concerning the protection of patents and of intellectual property in general.

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# Modern Uses of the Metal Aluminium*

## Its Mechanical and Chemical Properties Adapt It to a Number of Important Applications

By Richard Seligman, Ph.D.

ALUMINIUM, which is the chief component of all clays and an important constituent of many rocks, is one of the most widely distributed chemical elements. Despite this fact, it was not isolated until the year 1827, when Wöhler obtained the metal in the form of minute

Fig. 1.—A Fermenting Vessel Made of Aluminium Sheet for an American Brewery.

gray scales by the interaction of aluminium chloride and metallic potassium. Although this method was improved upon by St. Clair Deville, aluminium did not become a common metal until the simultaneous discoveries of Héroult and Hall in 1887-8 permitted of its manufacture by electrolysis. The process perfected by these two inventors, which is the only one in use to-day, consists in electrolyzing a solution of alumina in the molten double fluoride of aluminium and sodium known as cryolite. The electrodes used are made of carbon and the products of electrolysis are aluminium on the one hand and oxygen and the oxides of carbon on the other. The electrolysis is carried on at a temperature of 950-1,000 deg. Cent., so that the metal, which melts at 657 deg. Cent., is obtained in the molten form.

For close on ten years after these discoveries, aluminium was still regarded as little more than a scientific curiosity but more recently it has found its way into a rapidly increasing number of industries, for many of which it has become an essential.

The rapid development of the aluminium industry is an exemplification of the rule which, though universal, is frequently unrecognized—that supply creates demand. To show that the advance is in this case governed by this rule, it will be necessary to consider the uses to which the metal has been put during the last seven years. At the beginning of the period (1904-5), owing to the perfection of electrical methods of manufacture, aluminium had been available in large quantities for close on fifteen years but the world's output was only about 9,000 tons and the price $535 per ton; the amount produced was undoubtedly in excess of the consumption by no small amount and the makers held considerable stocks of the metal. At that time, the chief difficulty confronting the manufacturer was that of marketing his wares and in view of the hopes which had attended the inception of the industry the outlook was sufficiently discouraging. However, the time at which the aluminium industry was at its lowest ebb coincided very closely with the first strong impulse given to the automobile trade which was destined to carry it into the forefront of industrial undertakings. In the early days of self-propelled road vehicles, as at a more recent date in the case of aerial vehicles, every effort was made to lighten the burden placed upon the weak engines which did duty as tractors and in accomplishing this advantage was taken freely of the most salient feature of aluminium, its extraordinary lightness. Wherever possible, aluminium was used whether for engine parts or for the coach work. In a very short time the aluminium makers, who a few months before had been piling stock on stock, not only found their accumulations absorbed but their factories incapable of keeping pace with the rapidly growing demand. The writer can recall days as recent as 1906 when anxious hours were spent waiting for small consignments of a ton or two of metal from the reduction works to keep the rolling mills going, and when every corner and cranny was searched for bits of old scrap which could be remelted to feed the apparently insatiable motor trade.

Steps were at once taken to increase the capacity of the reduction works and the extension of old and the installation of new plants became the order of the day in two continents. But the aluminium maker is wedded, for better or worse (probably the latter), to water power, and as water power takes anything from eighteen months to four years to install, the automobile maker could not wait. Faced by the imperative necessity of finding a substitute for aluminium, wherever the latter could be dispensed with, he turned to thin steel sheets, which he found not only far cheaper but also to his surprise not markedly heavier. He had overlooked the fact that weight for weight steel is stronger than aluminium, so that for many purposes he was able to reduce the thickness of the metal used to such an extent that no material increase in weight resulted. Moreover, as engine power and efficiency were increased, gradually dead weight began to be of less importance, a process which we can see going on to-day in the development of aeroplanes. By the time then that the cumbrous water wheels, which had been installed all over Europe and America, had been made to revolve, the motor car had swept on its course and the aluminium maker was left with his enormously increased output but robbed of the outlet for which the output had been called into being.

Thus the supply was created. By 1910-11 the world's output had been raised to 34,000 tons and as the power available is now very great and many hydraulic installations which serve other processes would be available, in case of need, for the production of aluminium, the price is half what it was at the opening of the period under review.

Now as to the demand. Faced by a surplus of metal for which there was no outlet, the manufacturers set themselves to ascertain the fields in which aluminium might best find an application. As a consequence of systematic efforts to educate potential consumers, results have been attained which a few years ago seemed beyond the dreams of avarice. In different countries different lines of action have been pursued. Thus in America the chief new application found have been in culinary ware and the electrical industry; in Germany also the cooking utensil trade has reached enormous proportions, while a most promising outlet has been opened up in chemical apparatus; in France the motor trade still takes a very large amount of aluminium but a great deal of the metal produced in France finds its way into Germany to feed the industry there, no aluminium being made in Germany, which has to import all its raw metal from other countries. England, characteristically, was long content to send the metal made there abroad rather than go to the trouble either of creating new industries at home or of devoting energy to the studies necessary to enable her to do so. During the last two years, however, a great deal of spade work has been done and foundations have been laid upon which promising businesses in electrical and chemical apparatus are being built. Moreover, the motor trade, encouraged by low prices, is once more using the metal in large quantities.

In this article it is proposed to discuss the advantages and disadvantages which aluminium has for these purposes and to explain, as far as possible, the causes which have favored its introduction into each branch of industry.

### ELECTRICAL INDUSTRY.

Owing to its relatively high electrical conductivity, the metal aluminium is now playing an important and steadily growing part in the distribution of electrical

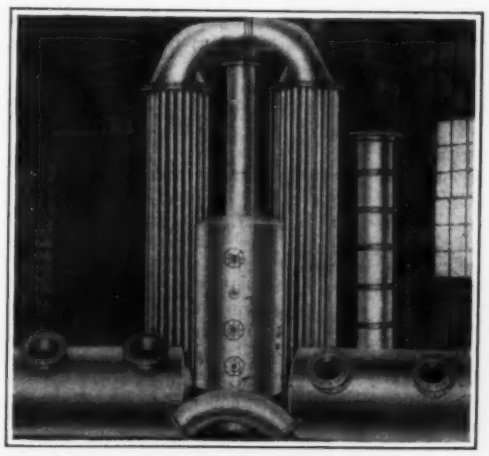

Fig. 3.—Parts of Two Aluminium Vacuum Stills, Condensers and Receivers for the Distillation of Fatty Acids.

power. Taking the conductance of a copper cable of unit cross section as 100, aluminium of the requisite purity has a conductance of 60, the exact figure depending, as in the case of copper, upon the purity of the metal and its physical state. To carry a given amount

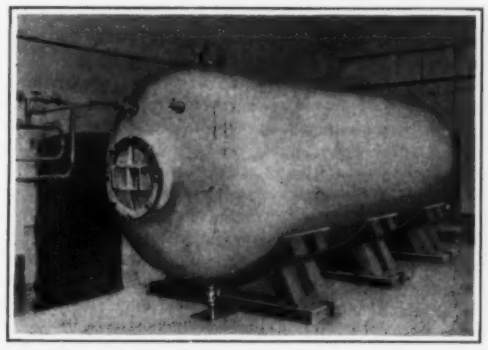

Fig. 2.—An Aluminium Pressure Vessel Having a Capacity of 1,800 Gallons and Made to Withstand a Pressure of 45 Pounds Per Square Inch.

of current, it is therefore necessary to take a bigger cable if aluminium be used, the cross section required being 1.66 that of copper. At first sight this does not seem promising but when it is remembered that the densities of aluminium and copper are 2.71 and 8.95, respectively, it will be seen that the *weights* of cable required to carry the same amount of current will be $1.66 \times 2.71 = 4.50$ in the case of aluminium and $1 \times 8.95 = 8.95$ in that of copper. In other words, half the weight of aluminium will be required and as the cost depends upon the weight and aluminium wire is little more expensive than copper wire per ton, a very large saving in capital outlay is effected by the use of aluminium instead of copper. In the case of bare, overhead conductors, such as are largely used in young countries to convey electrical energy, the full benefit of this economy is felt and there are in addition one or two subsidiary advantages such as the decreased cost of carriage to the point where the power line is to be erected, usually in remote parts to which the cost of carriage is heavy. On the other hand, the strength of aluminium is only half that of copper but as the area of the aluminium is 1.66 times that of the copper line, the strength of the former is $0.5 \times 1.66 = 0.83$ of that of the former. In consequence the sag between two poles or towers is greater where aluminium is used and the poles have therefore to be somewhat higher. The general conclusion to be drawn from these various considerations is very favorable to aluminium at the prices ruling to-day for the transmission of power by means of bare conductors.

Aluminium has so far not been found advantageous in cases in which small bare single wires are used, such as telephone and telegraph circuits. The explanation is to be found in chemical and mechanical rather than in electrical considerations. Aluminium, when exposed to the atmosphere, undergoes superficial oxidation but this ceases at a certain distance from the surface, the coating formed acting protectively. In the case of large conductors, corrosion does not proceed far enough to cause any trouble, whereas the strength of a small wire may be seriously impaired or the wire may even be corroded throughout its thickness. On the other hand, by using aluminium for large switchboard connections and for "bus bars" for internal transmission of heavy currents in power stations, etc., very considerable economy may be effected. The same advantage does not accrue from the use of aluminium for insulated and armored cables. Owing to the increased diameter of the conductor the amount of the dielectric or of the armoring has to be increased largely and the additional cost of the latter frequently more than neutralizes the saving made on the cost of the metal. At existing prices, there seems to be a marked saving in the case of single-core cables of large diameter which are not heavily insulated, whereas with three-core cables or insulted cables for high tension currents, the advantage stil rests with copper. Every case, therefore, requires separate consideration. A disadvantage attending the use of aluminium for all the purposes cited above is the difficulty of making joints, a difficulty which we shall see later has played so large a part in retarding the introduction of aluminium for chemical plants and one which is not

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to be met in the way found effective in the latter case. For electrical purposes, joints in aluminium conductors are usually made by purely mechanical means.

Aluminium is said to have been used successfully for battery connections in storage battery installations but the fact that in such a case it is in contact with the relatively highly electro-negative metal lead in an atmosphere which is always charged with sulphuric acid spray seems to make its use for this purpose particularly inadvisable.[1]

A most interesting and probably very important recent application of aluminium in the electrical industry, based upon its electrical, physical and chemical properties, now claims more than passing attention.

The manufacture of coils, whether for motors, dynamos or other electrical apparatus, involves the insulation of each turn of wire from its neighbor so as to insure that the current will pass only along the path ordained for it. One of the greatest problems which the designer of electrical machinery has to face is to get a sufficient number of turns into the space at disposal, which is usually very restricted. As has already been shown, an aluminium wire has to be materially larger than a copper wire, so that if it were necessary to insulate it in the way practised in the case of copper wire (wrapping with rubber, silk, etc), the use of aluminium would be very disadvantageous. Aluminium, however, has a chemical property which has been pressed into the service of the electrician in a most ingenious manner. The surface of the metal is normally covered by a thin, invisible coating of oxide. By immersing the metal in suitable solutions, this oxide film can be increased in thickness until it opposes sufficient resistance to the passage of a current to prevent a short circuit between two adjoining turns of wire in a coil. By this means it has been possible to make coils for electrical machinery which according to Mariage (*Tramway and Railway World*, May 4th, 1911) show a saving in weight of about 50 per cent (which owing to the position of the coils in electrically propelled vehicles is a saving of very great moment) and a reduction in cost of 60 per cent. Moreover, unlike the usual insulating material, being entirely inorganic, the coating made on aluminium is improved rather than damaged by heat, so that the danger of burning the insulation and so short circuiting the coils is diminished. On the other hand, the size of the coil must still be somewhat larger and the difficulty of making effective joints is greater than in the case of copper. Such coils have not been in use very long but their application seems to be increasing very rapidly and the writer is of the opinion that their ultimate adoption on a very large scale is assured.

Space does not allow of a detailed discussion of the use of aluminium in other directions in the electrical industry and mention can therefore only be made of such articles as current collectors on electric railways, fuses, lamp fittings, meter cases, lightning interrupters, etc., for all of which purposes aluminium is now in use to some extent.

In conclusion, it may be said that the very large development which is taking place in the introduction of aluminium for electrical work represents no mean achievement. Unlike some of the industries which will be considered later, the electrical industry was quite satisfied with copper and did not realize that the advantages which have been enumerated were attainable. It has been led to appreciate them by enlightened propaganda which benefited both the industries concerned.

TRANSPORT VEHICLES.

The rapidly growing use of aluminium in the construction of vehicles is based on several distinctive properties of the metal and its alloys. Before dwelling on these, it will be well to enumerate the actual uses to which the metal is being put. The principal users are the motor-car builders, who have applied the metal to making panels and moldings of carriage work, in the construction of the jackets and crank cases of the engine and for the gear-box and other casings of the transmission mechanism. Far less general at present is the use of aluminium in railway coach building, in which it is only used for paneling and in still rarer cases for door handles and similar minor fittings. In the case of aerial vehicles, aluminium is used in constructing seats, shields, instrument cases and, in fact, wherever lightness without strength is required. Formerly, aluminium was used in making the joints between members of the frame but this use of aluminium seems to be dying out; the classic cases of the Zeppelin airships and the Barrow airship represent isolated instances of abortive attempts to use aluminium and its alloys for constructional purposes in aerial work.

From the above it will be seen that aluminium is used either as sheet metal or in the form of castings.

Aluminium sheet was originally used for panels on account of its lightness. To-day a more important property of the metal is its extraordinary malleability, by reason of which panels of complicated shapes may be beaten out from it more cheaply than from thin sheet steel, unless a large number of similar panels are to be made, in which case costly machinery can be installed for the purpose. The surface of a well-made aluminium panel is also better than that of one made of steel, while wood, owing to the shrinkage which it undergoes, the amount of paint it absorbs and the difficulty of working it, is no longer used for motor-car work.

The advantages accruing from the use of aluminium for the purposes mentioned are not sufficiently marked, however, to induce makers to employ it unless the price of the metal be very low. It has been seen already that when the price rises appreciably, aluminium is discarded in favor of steel but at prices obtaining at the time of writing, aluminium panels are being used to a large extent.

The case of aluminium castings for engine parts is very different, as the advantages the metal has are very conspicuous and be the price high or low, very little else than aluminium is used. In the first instance, the saving of weight is very considerable, as such castings are of necessity bulky and if made in gun-metal or iron would burden the machinery to an excessive extent. The saving of cost is also very large indeed.

Pure aluminium is not used for this class of casting. When unalloyed, aluminium does not run at all well and in consequence small passages in the mold may not be well filled. Moreover, it often happens that portions of the molten metal which meet in the interior of the mold do not unite owing to the skin of oxide which covers their surfaces. Aluminium itself also lacks the necessary rigidity and the shrinkage of the metal on solidification (1.8 per cent) makes the production of sound castings difficult. Recourse is usually had to alloys containing about 10 to 12 per cent of zinc and 2 to 3 per cent of copper. These alloys have the properties which aluminium itself lacks and are more suitable even than other metals for the production of castings of intricate pattern. If the percentage of zinc be increased to excess, the castings are apt to break when exposed to continual vibration. In earlier days great trouble was experienced on this account but when the enormous number of castings in daily use is borne in mind, the number of breakages now occurring must be considered trifling.

HOUSEHOLD AND TRAVELING UTENSILS.

In discussing the application of aluminium to household purposes, traveling and military equipments, properties of the metal have to be considered which are of no account in the cases previously considered. The use of the metal for such purposes depends in the first instance upon the fact that compared with the materials heretofore used in kitchen and camp, aluminium is either infinitely safer from a hygienic point of view or far more durable. In this case, comparison lies between aluminium on the one hand and iron, copper, enameled iron and tinned iron on the other. For heavy cooking utensils, such as large kettles and heavy pans, iron still holds the field. Iron vessels, however, can be used only for a very limited number of purposes and are unsuitable for general use owing to the difficulty of keeping them clean and free from rust and the coloration and taste they impart to food. Their thermal properties also render them unsuitable for fine cookery.

Copper cannot be used safely owing to the solubility of copper in the weakly acid materials contained in foodstuffs and the fact that copper salts are most active poisons. Copper vessels, therefore, are coated with a thin layer of tin. This precaution is by no means sufficient to eliminate the danger, because the tin, sooner or later, wears off. Moreover, the cost of copper vessels is more than the purse of most housewives can bear and the cost of retinning is a permanently recurring charge. In point of price, aluminium cannot bear comparison either with tinned or enamelled iron but the life of the former is so very short that it does not form a serious competitor. Enameled iron may and frequently does give satisfaction on this score; on the other hand, it is entirely untrustworthy and in case of damage to the enamel it is the most dangerous material which can be used. There is in this case no question of poisoning as with copper but chips of enamel become intermixed with the food and probably are the cause of disorders such as appendicitis, etc., more frequently than is supposed. From all these disadvantages aluminium is absolutely free. Drawbacks of its own it has, but these are distinct from those cited above. Aluminium is second only to copper among the common metals in thermal conductivity and gives no color to the finest materials. Dirt is seen so easily upon its white surface that it is possible to tell at a glance whether it be clean or not. In addition to the fact that it dissolves but slowly in weak organic acids is the immensely important fact that even in solution it is entirely innocuous. Unlike tinned copper, tinned iron and enamelled iron, it is uniform throughout its thickness and consequently there is no coating to wear off, crack or chip. Having these advantages, the question may well be asked "How is it that its use is not universal?" The reasons are three in number. The cost of aluminium still places it above the reach of the poorest; the aluminium formerly used for the purpose was inferior; lastly, the metal cannot be cleaned by the methods generally in use in the kitchen.

The first of these statements need not detain us.

The inferior metal formerly and still occasionally used brought and brings its own Nemesis. It was stated above that the solubility of aluminium in weak organic acids is small and if it took place generally over the surface of the metal, it would be negligible. Unfortunately, however, this is not the case. The presence of small impurities in the metal or even of physical differences between adjacent particles, may lead to local dissolution and pitting or perforation of the metal. Owing to improvements in the methods of manufacture, the former trouble has been largely obviated and since the recognition of the importance of the physical state of the metal, still further improvement may be looked for. As a matter of fact, the degree of progress which has already been attained is very remarkable. In America and in Germany, millions of cooking utensils are made annually and the percentage of returns is nowadays very small indeed.

Now as to the third difficulty.

Aluminium unfortunately is readily attacked by alkalis and, therefore, the cleansing agent of the kitchen, soda, is one of its worst enemies. As a consequence, the cleansing of aluminium must be effected mechanically and entails appreciably more labor than if effected in the customary manner by means of alkali. This is the chief difficulty which remains to be overcome. In Germany, where the "hausfrau" herself takes pride in the appearance of her kitchen and herself does much of the cooking, it has not been sufficient to counteract the obvious advantages the metal has. One German factory known to the writer used in 1910 about 3,000 tons of aluminium, almost all of which was made into kitchen utensils. In the United States a huge business has been built up, mainly by the exertions of university students, who in their long vacation were engaged to educate the public to appreciate the advantages of aluminium; while even the Indian "ryot," who has always cleaned his pots and pans by polishing them with sand, is rapidly learning to substitute aluminium for the brass bowl prescribed by immemorial custom. Only in England is progress slow, mainly, in the writer's opinion, because in England the housewife does not cook and is not mistress in her own kitchen—where she walks in fear and trembling—and because no one has arisen who has had the courage to undertake the education of our national institution, Mary Ann.

In addition to the advantages cited above, the lightness of aluminium is the cause of its wide use for the field equipment of soldiers and travelers, to whom every ounce saved in the weight of water-bottle and cooking-pot is of importance. Moreover, the malleability of the metal renders it practically unbreakable, a factor of no small consequence when the treatment to which field equipment is subjected is borne in mind.

CHEMICAL PLANT.

The properties which have rendered the success of aluminium in the kitchen possible are also those upon which its claims as a material for the construction of chemical plant are based. This is true more especially of apparatus suitable for use in foodstuff factories, which have been erected in such large numbers during the past two decades. A modern jam factory, an extract of meat factory, a cordial factory, is each but a domestic kitchen magnified a thousandfold, a well-equipped condensed milk or margarine works being but the apotheosis of a dairy, where purity of taste and color and freedom from infection must and do reign supreme.

The chief attraction which aluminium offers to the maker of foodstuffs lies in the fact that aluminium salts can be consumed in considerable quantities without exerting any injurious effects whatsoever upon the human system. If this fact be of importance in the kitchen, it is immeasurably more important in the factory, as the introduction of poisonous material derived from the apparatus used on a large scale would endanger the health of thousands of people, to say nothing of the reputation and consequently the success of the manufacturer. Many metallic salts, especially those of the heavy metals, act as specific poisons on the human system but aluminium salts have no such deleterious property. As it is not absorbed by the mucous membrane of the stomach, aluminium has no chance of exerting any objectionable effect, being rejected by the system *in toto* (*Siem. Dissertation Dorpath*, 1886; *Plagge u. Lebbin, Veröff. des Militar Sanitäts Wesens*, 1893; Herbert, Acad. des Sciences, 1907, etc.).

[1] Since writing the above, the writer has had an opportunity of carefully inspecting a storage battery room in a large London power station in which the conductors are almost exclusively made of aluminium rods. These conductors were installed about two years ago and are giving great satisfaction. At first there was some difficulty of the nature indicated in the text of this article but it has been overcome by coating the aluminium with an acid-resisting paint. It is clear that so long as steps are taken to prevent the film of electrolyte which forms over the junction of the two metals from being in electrical contact with both or either of them, galvanic action cannot take place. Vaseline seems to be very effective in this way.

Thus it comes about that even if aluminium were readily dissolved by foodstuffs, it would nevertheless be harmless. But we have seen already that aluminium is but very slightly attacked by weak organic acids, so that the use of this metal is attended with complete safety.

In this respect, aluminium stands pre-eminent among the metals, its only rival being perhaps tin, which owes its popularity to its insolubility in weak acids. Once formed, however, its salts are poisonous. But tin, in addition to its costliness, is deficient in the mechanical properties which are required for the construction of a large chemical plant. It is, therefore, generally used only as a thin coating on other metals—copper, lead or iron.

In this connection, reference may be made to one particular living organism toward which aluminium is entirely inactive, namely, yeast, a property whch renders the metal one of extreme importance to brewers. Brewing is an industry which is carried on under the most stringent conditions of asepticism. The demands made upon the modern brewer are such that foreign organisms of every kind have to be excluded rigidly, the most painstaking precautions being taken to attain this end. One of these is the gradual elimination of wooden vessels, which on account of their porosity tend to harbor bacteria and are cleansed with difficulty. In place of wood, both copper and enameled iron have been used but it has been found (Chapman, *Journal of the Institute of Brewing*, 1909) that under certain conditions copper is dissolved by beer worts at the air-water line and that the copper which enters into solution affects in a very marked extent the reproductive power and fermentative vigor of yeast. Enamel is free from this objection but it is easily damaged, so that the iron subsurface becomes exposed and rusts, so affecting both the taste and the brilliancy of beer.

Chapman has shown that the salts of aluminium do not affect yeast in the very least (*ibid.* 1911), the yeast cell disregarding the presence of aluminium salts exactly as the human stomach does. This neutral property of aluminium, taken in conjunction with the fact that its solubility in sound beer is extremely small, have led to the rapid introduction of brewery plant made of aluminium.

The vessels used for this purpose are of exceptional size, some of them holding 25,000 to 30,000 gallons of beer. To manufacture such tanks of aluminium was quite beyond the capacity of manufacturers until very recently but new processes have been evolved (to which reference will be made later) by which vessels of this size can now be made and a new industry based thereon has arisen. The accompanying illustrations show both a fermenting tank made of aluminium and also a vessel in which secondary fermentation takes place under pressure, the carbon dioxide evolved being imprisoned and dissolved in the beer. These tanks, which are being used in rapidly increasing numbers, have to withstand considerable pressures, so that their manufacture places no small demand upon the skill of the makers.

The second consideration which has led to the adoption of aluminium in many cases is the fact that the salts of aluminium, without known exception, are colorless. In this respect it differs from practically all the other common metals used by chemists. All the salts of copper and iron are colored, while both lead and tin easily give rise to discoloration. In many industries this fact is of great importance, as it is often impossible to prevent dissolution altogether, and in such cases the certainty that no discoloration will follow from the introduction into a product of small quantities of the metal of which the containing vessels are made is an obvious advantage. Many examples might be quoted in illustration but two or three will suffice. In making varnish, various gums, oils and resins are heated in small metal pots, over a direct fire, at temperatures varying from 350 to 400 deg. Cent. At this temperature, the lower boiling constituents distill off but condense in part on the upper and cooler surface of the vessel, thence flowing back into the main bulk of material; these volatile constituents often attack metals very freely and if, as has been the practice, iron or copper vessels are used, the condensate is brightly colored—brown or green, as the case may be. As one great object of the varnish maker is to obtain a colorless product, the use of aluminium is remarkably advantageous. The comparative weakness of aluminium at the high temperatures which are customary in varnish-making was at first considered to be a drawback to the use of the metal but in practice it has been found that this is more than offset by the fact that aluminium is unaffected by furnace gases. The sulphur compounds of aluminium are only formed with great difficulty and as it is the sulphur from the coke fires which plays havoc with copper and iron varnish pots, this cause of deterioration is inoperative in the case of aluminium.

The second case to be examined under this heading embraces industries such as those engaged in the manufacture of jams, preserves, fruit and other essences, in which materials are used which either contain acids or from which acids are easily produced. Jam boilers, for instance, use copper boilers. Although the amount of copper dissolved by fresh fruit is insignificant, if left uncleaned a jam pan will acquire a green coating of copper salts in the course of an hour, owing to the attack of the copper by the acids in conjunction with the oxygen of the air. This difficulty obtains in a number of trade and in some cases, as, for instance, the distillation of the higher fatty acids, it is necessary to reject, owing to their bright green color, the first runnings from the condensers if the still has stood idle for a few hours. Here again aluminium offers a definite advantage, combined of course, in the case of materials destined for human consumption, with the fact already referred to, that no poison can gain an entry.

There now remains to be considered the fact that a number of chemicals which attack most metals vigorously dissolve aluminium with extreme reluctance. The most striking instance of this kind is indubitably that of nitric acid. This materal, generally considered to be the most corrosive of chemicals, attacks aluminium so slowly that pipes, tanks, hoods and even pumps of the metal are used on a large scale both in the manufacture of the acid and in the manufacture of explosives in which nitric acid is used. In the process which is now being worked on a very large scale, whereby oxides of nitrogen are produced from the air by electric discharges, the cooled gases are conveyed through aluminium pipes to the towers in which nitric acid is produced.

Sulphurous acid and sulphuretted hydrogen are similarly without effect on aluminium but advantage has not been taken of this fact to any great extent at present.

Of far greater importance is the fact that of all the common metals aluminium is the least attacked by the higher fatty acids of which the bulk of the vegetable and animal oils are composed (G. A. Emery, Report of the U. S. Dept. of Agric., p. 265, 1909). Immense quantities of these oils are now converted into food-stuffs in the form of margarine and similar products, and it has been found that aluminium is the most suitable metal to use in the construction of the plant required. Not only do the advantages of color and immunity from toxic effect apply in full force but the metal is actually unattacked by these materials, some of which, such as oleic acid for instance, corrode other metals with great rapidity.

In the foregoing account no attempt has been made to enumerate all the uses to which aluminium is being put in the chemical trade; only a few examples have been selected to illustrate properties of the metal of which advantage is being taken in various industries. Though these properties have long been recognized, aluminium has been used by chemists only to a very limited extent on account of the difficulty of uniting sheets of the metal, which until quite recently prevented the manufacture of any but small articles of aluminium such as domestic utensils or such chemical vessels as could be made in the shape of castings. Aluminium is the most electro-positive of all the metals used in the industries and in consequence suffers corrosion when in contact with other metals with extraordinary readiness. Inventors of solders for joining aluminium have invariably split on this rock. It is usually considered impossible to solder aluminium but this is by no means the case. Aluminium can be soldered quite readily but the soldered joints corrode rapidly owing to the fact that electrolysis is induced at the joint by the contact of the metal and solder. On the other hand, aluminium cannot be riveted so well as other metals, on account of the softness of the metal, a difficulty not readily overcome; the rivets are apt to draw out, giving rise to leakage, especially under the influence of temperature variations and vigration. Quite recently means have been found to apply the lead burner's method of jointing to aluminium. A lead burner fuses two sheets of lead together without the interposition of any foreign metal. The same method has now been adopted for the jointing of aluminium, the only difference being that fluxes are required in the case of aluminium to remove the oxide film with which the surface of the metal is normally coated. Although apparently so small a point, it has been thought well to lay stress on this matter because of the consequences with which it is fraught. Until the method of jointing by autogenous soldering was perfected the use of aluminium in the chemical industries could not be made general. By its introduction a weapon has been forged which has enabled those who have devoted themselves to the solution of the problem to place at the service of the chemist and chemical engineer a metal with which, on account of its special properties, many grave difficulties affecting the use of other metals may be overcome; above all to render the manufacture of all materials destined for human consumption safe and hygienic. The difficulties which have so long stood in the way of the manufacture of aluminium apparatus on any but the most restricted scale, in fact, may now be said to have disappeared and the photographs which illustrate this portion of the article are sufficient evidence that any apparatus which the chemist may require to have made in aluminium is now readily obtainable.

# The Agricultural Motor Contest at Chelles

## A Comparison of European and American Machines

### By Lucien Fournier and L. W. Ellis

"MOTOCULTURE," or tillage of the soil by other than human or animal power, has hitherto had only moderate success in France, although it has been adopted on numerous large farms, many of whose proprietors are disposed to replace their old machinery by a new and more effective equipment. The farmers cannot be held responsible for a situation of which they are merely the victims. They would be very glad to conform to modern requirements and to purchase powerful and effective machinery, but they cannot find it.

French makers of agricultural machinery have allowed themselves to be outstripped by those of other countries, who long ago began the study of apparatus suitable for motoculture. Three or four French constructors have made some progress and are ready to furnish good machinery, but the others are still studying a single type which they are incessantly modifying. Silbernagel, who is the protagonist of motoculture in France, recently told one of the writers that of twenty-seven constructors, only four were able to deliver machines, and that the others possessed only one model, in regard to which they could not furnish either a statement of prices or of conditions of efficiency.

The question has been regarded from two different points of view, and the constructors, as well as the agriculturists, are divided into two classes: the partisans of automobile plows and those of plows drawn by cables. The important question, however, is not that of the method of propulsion or traction, but that of the construction of the tool which actually works the soil. French engineers have calculated that the work of the ordinary plows ranges from 2,800 to 7,200 kilogrammemeters (20,000 to 52,000 foot-pounds) per cubic meter (35.3 cubic feet) of earth turned over. The work done by the spade in human hands is only 1,150 to 2,200 kilogramme-meters (8,300 to 15,900 foot-pounds) per cubic meter of earth. From this it appears that the spade is far more efficient than the plow, and this discovery leads to the inference that the question of motoculture involves the development of tools specially suitable for the purpose. The spade is well adapted for human hands, the plow for animal traction, but a tool differing from either will probably be found best for use with steam or other motors. M. Silbernagel protests against the common idea that the plow is indispensable for working the soil. Strips of each can be marked off and turned over, he says, in exactly the same manner by thirty-six different mechanical devices.

The problem of motoculture is at present the subject of much study and controversy in France. A practical solution will probably soon be reached, but is not yet at hand. This, at least, is the impression made upon the writer by the last competitive exhibition, in which very few constructors took part. It is true that the season was not the most favorable. The friends of motoculture are looking forward eagerly to the exhibition to be held by the French Association for Motoculture at Rheims, in September.

In the present paper we shall speak only of a few machines which were shown at the last exhibition at Chelles. This French contest was of greater interest than any similar competition ever held, not even excepting the famous contests held annually at Winnipeg, Manitoba. The trials at Chelles brought forth only five machines, one of which, the Gilbert, which will be discussed later, was forced to withdraw, because of

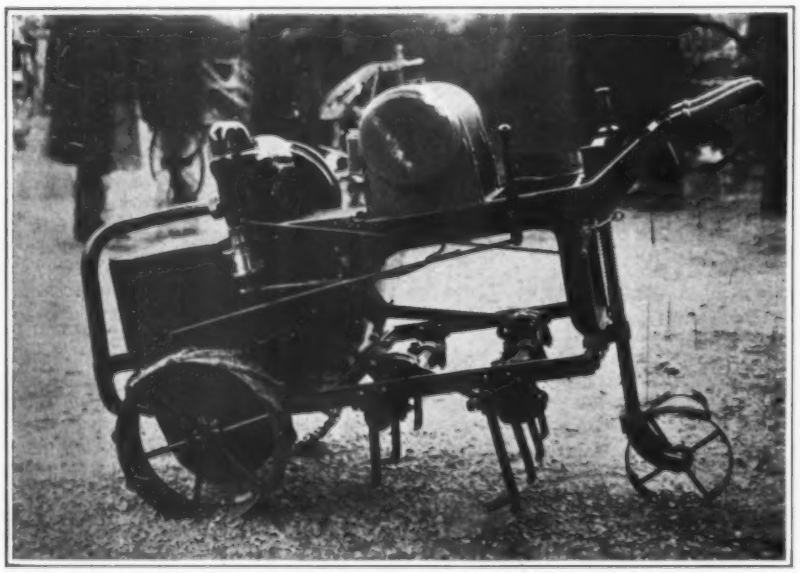
A Cima Gasoline Tractor Drawing a Mogul Plow

Arion Tractor at Work Hauling a Reversible Plow

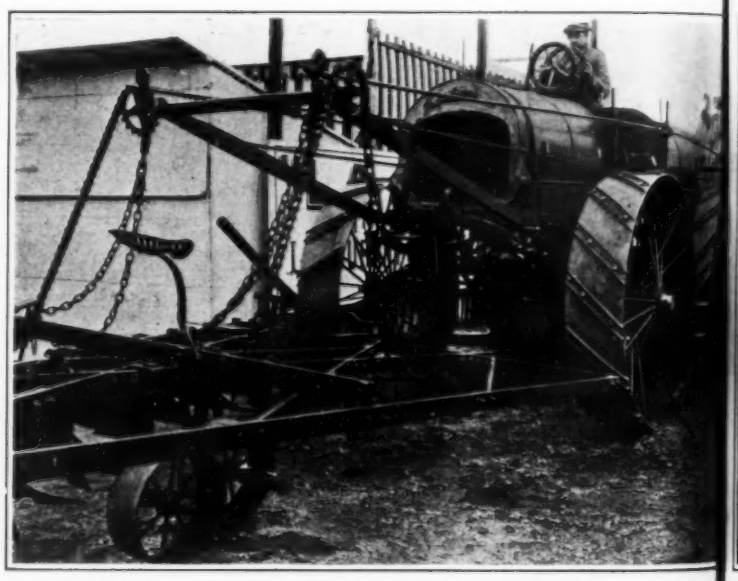
Lefebvre Tractor With Adhesion Chain Lowered, Drawing a Reversible Triple Plow

## TILLING THE BY

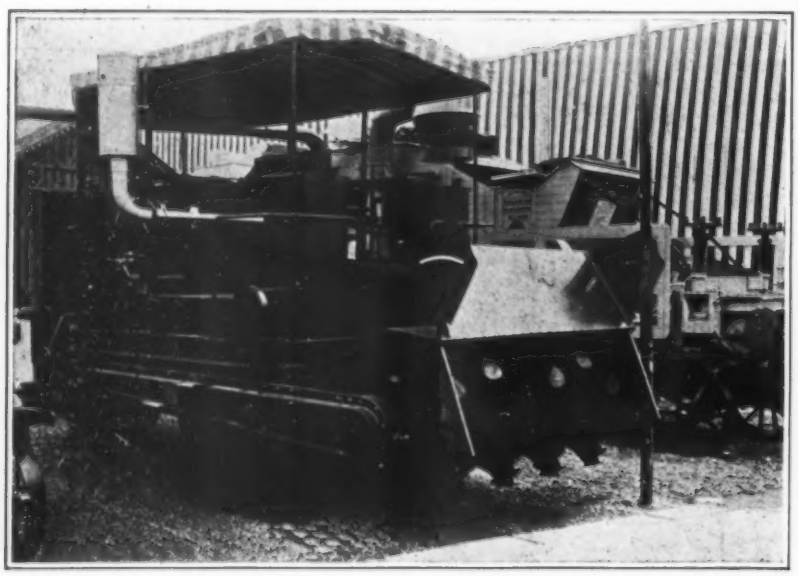
THE problem of moto-culture is at pr subj Mechanical tillage of the soil has hither only m agricultural machinery have allowed th to be long ago began the study of apparatus suitable -cultu different points of view, and the constructor as th partisans of automobile plows and those of plo by not that of the method of propulsion or tractio of th the soil. The partisans of each class had an ity of motor contest held at Chelles, France. The was of international in character, because, in a word en wer enabled to prove their comparative merits recisely offered by European inventors has been produ uccess although the work of Americans has been ove by th the accompanying article will be found an im dgmen entered, written by two men who have a right author to farmers in all civilized countries.



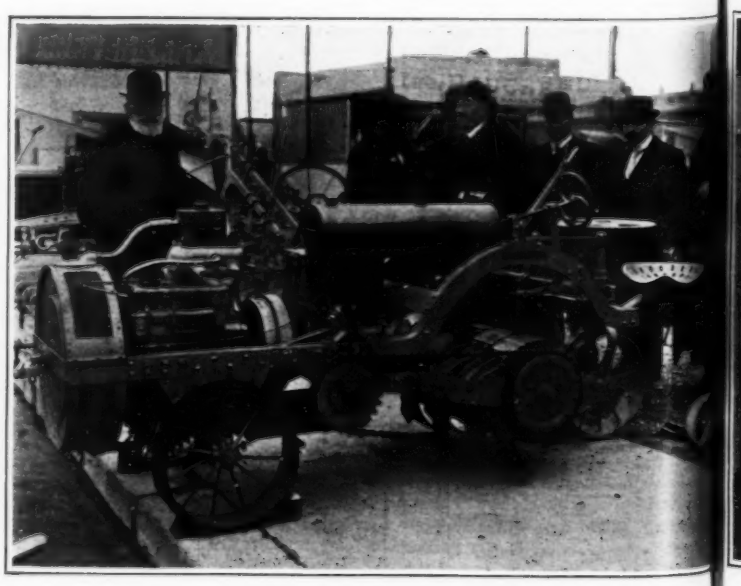
A Hand-steered Motor Hoe to Which a Great Variety of Cultivating Tools May be Attached



Mondiale Automobile Plow, A Heavy Machine With Four Drive Wheels; Runs Equally Well in Either Direction



The Koszegy Cultivator, a Huge Machine Adapted for All-around Work on the Field



The Chouchak Cable Tractor, Invented by a Russian and Exhibited by M. Bajac

Lefebvre Tractor With Adhesion Chain Raised

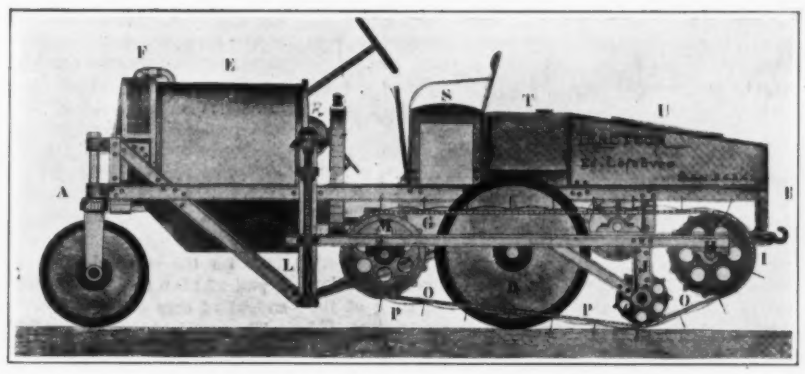



Diagram Showing the Parts of the Lefebvre Tractor

## LLING THE BY AUTOMOBILE

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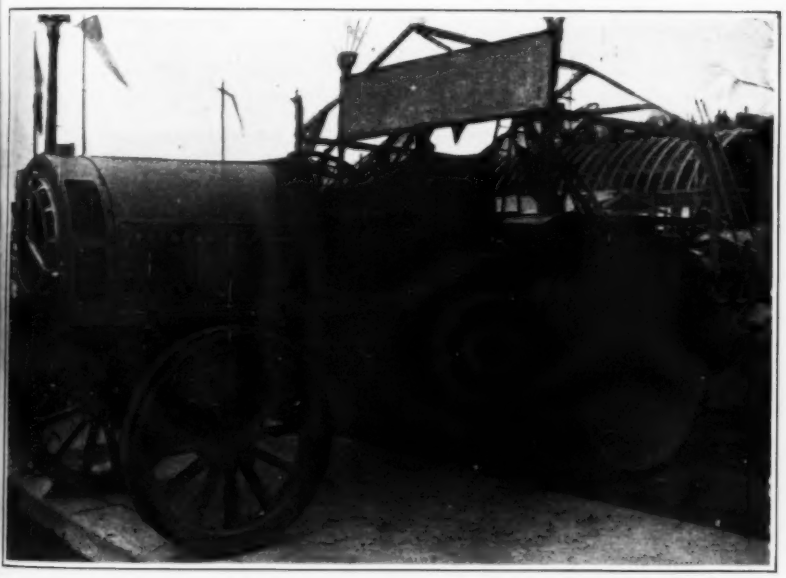
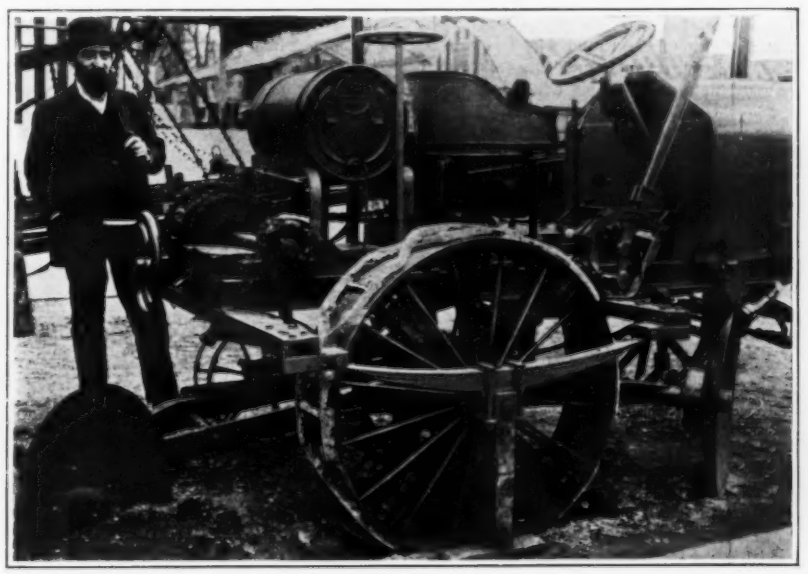
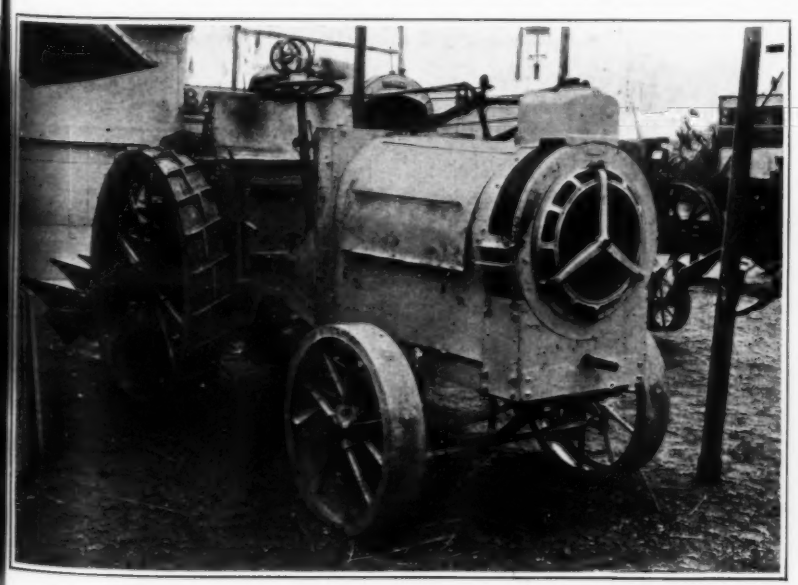
The Case Type of Steam Tractor, Pulling Eight 14-inch Sod-breaking Plows



This Tractor is Provided With an Auxiliary Winding Gear for Cable Propulsion When This May be Found Necessary or Advisable



The Gilbert Disk Plowing Machine, Which Was Disqualified at the Competition Through the Stripping on the Spur Gear



The Linard-Hubert Motor Plow and Hoeing Machine. The Plows Are Fastened to a Tubular Frame, Raised and Lowered by the Motor

Arion Tractor for Heavy Clay Soils, Showing the Cables Wrapped Around Grooved Pulleys

the stripping of a spur gear. The other four were strikingly representative of successive types in an evolution which has begun in the United States and which may be completed within the lifetime of our present agricultural engineers.

DESCRIPTION OF THE MACHINES.

*The Cima Tractor.*—The Cima tractor (made by the International Harvester Company, in France) is composed of a chassis carrying a horizontal motor with two fly wheels. The whole rests upon two small front wheels and two large rear wheels, the latter being the drivers. The mechanism is similar to that of ordinary automobiles. The motor is of 28 horse-power and makes 230 to 290 revolutions per minute. The tires of the driving wheels have a width of 55 centimeters (22 inches), which, however, can be increased by an extension device to 75 centimeters (29½ inches) for use on very wet soil. The whole machine is 4.96 meters (about 16 feet) long and 2.46 meters (about 8 feet) wide. It draws a Mogul (Parlin & Orendorff) plow attached directly behind it and having five independent plowshares, each of which is fitted with a lever by which it can be raised and lowered, so that from one to five shares can be used, according to the character of the work. There is also a special device which lifts each plowshare on meeting a rock or other obstacle. The fuel employed is benzol, of which about 15 liters (32 pints) are required per hour. With two men, one on the tractor and the other on the plow, and using all five plowshares, 40 or 50 ares (1 to 1.25 acres) can be plowed to an average depth of 15 or 18 centimeters (6 or 7 inches) in one hour, at a cost of 9 to 12 francs ($1.74 to $2.32).

The Cima, or International Harvester Company's gasoline tractor, was attached to a four-bottom gang plow, but owing to the stiff and adhesive character of the soil, one of the shares had to be raised, after which the other three plowed to a depth of 5 or 6 inches. These trials took place on a field with a heavy clay soil which was in rather soft condition, owing to heavy rains, consequently the experience of the round-wheel tractor is typical of similar cases that happen in every American locality where tractors are used. The tractive efficiency of the round wheel is considerably diminished by soft ground, and this loss is reflected in the reduced number of plows which can be pulled.

*The Case Traction Engine.*—The J. I. Case Threshing Machine Company of America has introduced its traction engines in France, where they are highly appreciated. These engines, which are propelled by steam, need no detailed description in an American journal. At the recent competition a Case engine of 45 brake horse-power drew an American plow with five shares, penetrating the soil to a depth of 30 centimeters (12 inches). In a day of ten hours 4 hectares (10 acres) were plowed with this apparatus. The operating cost is about 15 francs per hectare ($1.20 per acre), including coal, oil and labor. In a trial made on a large farm in the south of France, 1.5 hectares (3.7 acres) were plowed to a depth of 33 centimeters (13 inches) in one day at a total cost of 42.50 francs ($8.20). An English journal, the *Implement and Machinery Review*, remarks that this engine showed a large capacity for work, but too much time was spent in replenishing the water tanks. This repeats in miniature the experience of American farmers, who have largely shifted their favor from steam to internal-combustion tractors for this very reason, in spite of the great capacity and thorough reliability of the steam traction engine.

*The Lefebvre Tractor.*—The Lefebvre tractor uses benzol as fuel. It is composed, as the accompanying diagram shows, of a chassis of profile iron resting on three wheels. The front wheel *C* is a steering wheel, the two rear wheels *D* are drivers and sustain most of the weight. The motor, placed in front, is of 24 to 30 horse-power.) The motor drives the rear wheels, which are mounted on a differential, through the intermediation of a speed chamber, which may be set to three, four, five or nine kilometers (1.9, 2.5, 3.1 or 5.6 miles) per hour. By the side of this mechanical part, which is common to all automobiles, is placed a construction devised for the purpose of increasing adhesion to the ground. In most tractors this adhesion is produced entirely by the weight of the machine. In a plowing engine this fact entails certain disadvantages, notably the excessive packing of the soil in front of the plow. In order to be able to lighten the machine without diminishing the adhesion, M. Lefebvre has placed at each side of the main frame a pair of longitudinal beams *J J H*, carrying toothed wheels *M H*, over which pass chains *O*, bearing transverse blades of steel *P*. The entire auxiliary frame is movable about the axle *H* and the extremity *J* is articulated with a vertical screw which is turned by means of a wheel *R* operating upon bevel pinions. When the machine is traveling along the road the adhesion frame is raised and the chain carrying the blades is removed from contact with the ground. When the field of work is reached the frame is let down and the blades bury themselves in the soil, which they enter and leave vertically by means of the action of a toothed disk *Q*. The Lefebvre tractor shown in the accompanying photograph was exhibited at the recent agricultural fair, and it took part in the experiments at Chelles-Gournay, which took place after the fair. The motor is of 24 to 30 horse-power, and the whole machine weighs only 2,500 kilogrammes (5,510 pounds). In ordinary traction engines the drawbar pull is only from 20 to 25 per cent of the weight sustained by the driving wheels. Hence a pull of 1,000 kilogrammes would require a weight of 4,000 to 5,000 kilogrammes on the drivers, or a weight of 5,000 or 6,000 for the whole machine. In the Lefebvre tractor a pull of 1,000 to 1,200 kilogrammes is obtained with a weight of only 2,800 kilogrammes.

The power of the engine of this tractor was much less than in the International Harvester Company (or Cima) tractor, yet the three-furrow balance plow was drawn at the same depth and speed. Contrary to expectations, the endless chain did not clog up sufficiently to impair its efficiency. The effect of the larger bearing surface was such as to increase very materially the pulling power of the tractor. Moreover, the fact that this chain may be raised out of the way for driving on hard roads suggests that a very efficient combination might be worked out, retaining the advantage of the round wheel as to durability and simplicity for all ordinary work, with all the increased gripping power of the chain for soft ground.

TILLING MACHINES.

A large school of inventors has been possessed with the idea of embodying the tillage mechanism in the frame which contains the motor and traction mechanism. The Gilbert machine, which failed to complete the tests at Chelles, is one of these. M. Pierre Gilbert was one of the first to attempt to solve the problems of motoculture in France, having assisted to produce the Landrin disk plow machine. The latter is one of the few practical machines to date in which the engine which drives the entire vehicle forward also actuates a mechanism for tilling the soil. In the Landrin machine, three large disks on a square shaft at the rear of the machine are capable of being rotated at different speeds so as to produce exactly the right pulverizing effect in different conditions of soil. In the Gilbert machine no provision is made as yet for varying the speed of the disks, these being allowed to rotate of themselves as the forward motion of the machine places resistance upon them. The forward disk cuts a shallow furrow in which the drive wheel runs, while the rear disk, which is really the working feature, cuts much deeper. The depth of the disks can be regulated by a lever, and other means are provided for keeping the chassis level, no matter how deep the furrow is cut in which the drive wheel runs. One feature of the drive wheel which has been used on a number of American tractors is that of movable dogs or lugs fastened to an eccentric at the axle so that they may be forced outward to a greater or less distance, thus adding to the gripping capacity of the wheel.

THE LINARD-HUBERT MOTOR PLOW.

Another form of motor plow having resemblance to certain American types is the Linard-Hubert, shown at Paris by La Champenoise of Troyes. This firm now uses ordinary shares and mold boards, having abandoned the idea of giving them a reciprocating motion. The latter requires much extra mechanism, greater power and much greater care in keeping the outfit in working condition. The plows are fastened to a tubular frame which is raised or lowered by the power of the motor. Flat friction disks hold the plow bottom to the frame and offer a yielding factor of safety in case of obstructions.

THE BENEDETTI MOTOR PLOW.

La Mondiale motor plow, formerly known as the Benedetti, is a tremendously large, heavy machine with four drive wheels. This can be run equally well in either direction, two steering wheels being provided. There are also two frames bearing nine plows each, one of which is at either end of the machine. The plows are raised and lowered in much the same manner as the steam-lift plows formerly popular in the United States. This costly, cumbersome machine saves the necessity of turning, but suggests few advantages in any other direction.

THE BAJAC TRACTOR.

M. Bajac has had on the market for some time the large tractor shown in one illustration, intended for use in pulling any kind of plows or cultivating implements. Like the American farmobile mentioned below, his motor was equipped with an auxiliary winding gear with a cable for use in emergencies. This year he added to his exhibit at Paris the Chouchak rotary cultivating machine, the product of an inventor of the same name, at Kertch, Russia. The drive wheels are in front, driven by chain from a secondary shaft, the same shaft also furnishing power for driving the rotary cylinder at the rear, which supports the rigid hoe-shaped cultivating tools. These tools are cleaned at each revolution by a cam-operated plate which scrapes the surface of the hoe. An apparent objection to the rigid hoe is its probable destruction in case of rocky soil.

THE MOTOR HOE.

Another interesting machine is the motor hoe. The front wheels are driven and the outfit is steered by the operator, who also gages the depth by the handles at the rear. A great variety of cultivating tools may be attached and this small outfit seems to have a logical future among large truck gardeners near centers of population.

THE ARION TRACTOR.

The Arion tractor moves by hauling itself along a fixed cable, the ends of which are attached to anchoring devices at each end of the field to be plowed. As it does not require adhesion to the ground, this tractor can be very lightly constructed. It weighs, in fact, only 1,500 kilogrammes (3,306 pounds). An ordinary four-wheeled chassis carries a 30 horse-power motor having a normal speed of 450 revolutions per minute. The number of rotations per minute, however, can be varied from 350 to 700, so that no speed changer is required. The speed of travel varies between 1 and 6 kilometers (0.6 and 3.7 miles) per hour. The propulsion system is composed of two peculiarly constructed pulleys, provided with grooves for the reception of the fixed cable, to which they adhere perfectly and without slip. By using pulleys of different size, further variation in speed of travel can be obtained. By the rotation of the pulleys the tractor and the plow attached to it are drawn from one end of the cable to the other. The cable, composed of steel wire, has a diameter of 15 millimeters (0.6 inch), and a breaking strength of 15 tons. The ends of the cable are attached to two small four-wheeled steel cars. One of these cars carries a winch, on which the cable can be wound for transport from one field to another, and by means of which the length of the cable is adjusted to that of the field. Each of the cars is anchored to the ground by two sheet iron disks attached to the outer faces of two of its wheels. These disks cut deeply into the ground and offer resistance to transverse displacement of the car. They are so mounted that they can be removed for transportation and that, when in use, they are slightly dished in a manner which increases their rigidity. With a Brabant plow of 30 to 35 centimeters (12 to 13 inches) draft, the Arion tractor can plow 1.5 hectares (3.7 acres) per day. The consumption of benzol is from 40 to 50 liters per hectare in soils requiring a traction of 700 to 800 kilometers (1,543 to 1,764 pounds). In one day, 3 hectares (7.4 acres) can be plowed to a depth of 18 centimeters (7 inches) with a consumption of 20 liters of benzol per hectare (18 pints per acre).

A similar machine was made a few years ago by a concern at Columbus, Ohio. Their farmobile used the cable, however, as an auxiliary device, which became operative only after the traction wheels had slipped sufficiently. This left their tractor free for use in road haulage or in pulling binders, etc., a desirable feature which the manufacturer of the Arion tractor evidently overlooked. The cable system as used by the Fowlers, of Leeds, England, was the first by means of which mechanical power was used in plowing. Their most successful system requires the use of two engines stationed at opposite ends of the field, equipped with a winding drum for pulling the plow back and forth. It is still in successful use in many parts of the world, where deep plowing is essential, for instance, among the sugar beet and sugar corn raisers. The cost of the two engines and the tackle, which can be reduced by using a much longer cable and a less convenient system of anchors and pulleys, has been a serious handicap against its general adoption. Some form of reversible plow is necessary in connection with all cable systems. The form commonly used with the Fowler system is shown in the picture of the Lefebvre tractor, while a second form, known as the turn-wrest plow, is seen in the picture of the Arion machine at work.

THE KOSZEGY ROTARY TILLAGE MACHINE.

The fourth machine, of which we have such an excellent photograph, is suggestive of a complete revolution in tilling machinery which may eventually come. This is the Koszegy rotary tillage machine, in which we find the plow entirely dispensed with and its place taken by a rotary mechanism which combines the plow, the disk, the harrow and practically all other implements for tilling and pulverizing the soil. This is a tremendously large machine, embodying the ordinary features of a traction engine driven by a four-cylinder motor, and in addition a chain-driven drum at the rear, to which are attached the cultivating tools. This drum may be raised or lowered to regulate the depth to which the ground is worked. Ten steel disks, set in a plane at right angles to the drum shaft and carrying six hoe-shaped tools each, form the cutting mechanism, the idea being to break up the soil into clods and destroy weeds as well as bury them. This principle has been worked out with fair success by numerous other inventors, a notable case being that of Konrad von Meyenburg, of Balse, Switzerland.

In the trial at Chelles the drum of the Koszegy ma-

chine rotated at about 100 revolutions per minute, demonstrating its entire efficiency in wet soil to which it was not thought to be adapted. The tools pulverized the soil to a depth of about four inches, acting much on the principle of a milling machine in a steel-working shop. The pulverized earth, according to *Implement and Machinery Review*, was carried over the drum like a sheet of water over a water wheel, falling in an even layer of very small clods and giving the appearance of a field after being thoroughly harrowed. The weeds were pulled up, shaken free of earth and left on the surface, which would insure their complete destruction in dry weather. Experts who watched the working of this machine, and especially visitors from Tunis and Algeria, maintained that an instrument of this sort would be ideal for dry-farming. In hard-packed soils, plows are frequently useless, whereas the milling machine would easily pulverize the earth and leave it in the exact condition most favorable for the storage of moisture without any additional treatment by the harrow.

LESSONS OF THE CHELLES CONTEST.

In the trials of the four machines at Chelles we see what is possibly the greatest single advantage of the gas tractor, and one which has led to its final supremacy in the United States. We see demonstrated the endless chain, the supremacy of which as a traction mechanism has long been admitted in theory, even though mechanical objections have still made for the greater popularity of the round-wheel tractor. These three machines represent the types upon which American manufacturers have spent the greater part of their effort. The effort on this side has been to substitute a better motor for the horse, using in connection therewith the plows, drills, harrows and binders developed for animal power. We have a radical improvement of the latter machines and, especially in the case of the plow, a radical change in construction, as these implements were better adapted for use with tractors. The art rests at that point in America to-day. Few, if any, manufacturers are looking further ahead than the perfection of direct-pulling tractors which will give under all circumstances as general satisfaction as the farmer has with his horse.

The French have not gone as far as we have in supplying a practicable farmobile, partly owing to the fact that there has not been the same demand for cultivation of enormous areas by any means, good or bad, and partly owing to the endeavor of some of the foremost French engineers to go to the very root of the matter and find the ultimate solution before giving the farmer anything whatsoever of this sort. They have worked very little upon the direct traction system, that is, the method of hitching some sort of plow behind tractors that will pull not only plows but many other forms of machinery. They have gone further, and in some cases attempted to combine the plow in a frame with the motor, while in others they have attempted to displace the plow altogether. M. Silbernagel, probably the leading advocate of motoculture in France, insists that the present form of plow is not necessary nor logical, and in face of the many forms of rotary harrows which we are now using successfully in this country, perhaps he is right. Yet we should not attempt to dispense with the plow all at once. French engineers who have attempted it have encountered the same great difficulties that have filled the blacksmith shops and barns of our Northwest with the relics of inventors' dreams and disappointed hopes. Practically every foreign machine described in this article has its counterpart in the United States, and if the score were taken of American inventors of such types who were able to supply the trade with working machines, it would not be much higher than in the case of the French constructors of similar types in this country.

From the foregoing it is evident that the adaptation of mechanical power to the farmer's use is not a simple problem.

Pratically every device offered by foreign inventors has been produced in as successful a manner by inventors in the United States, although the work of the latter has been overshadowed by the success of the ordinary traction engine.

The objections to the various substitutes which have resulted in the practical supremacy of the direct tractor are easily stated. In the double engine and cable system, which is costly both in outlay and in operation, the capacity is limited and the outfits not adapted to use in large fields on account of the limitation to the length of the cables. Autoplows, that is, machines containing plows closely combined in a frame, together with the motor and driving mechanism, have the advantage of being easily worked in corners, but makers of this type of machine overlook the fact that plowing is only one of the many operations which must be accomplished. The harvester cannot be slung under the tractor frame, neither can the disk nor the drill, and the shift in the distribution of weight in the different operations may effect a serious loss in tractive efficiency.

The prediction is made that we may some day see a transferable power plant with a base provided for it on every tilling and harvesting machine, which will thus be made self-propelling without duplicating the most costly part of the equipment, the motor itself. One French school suggests the use of animals for propelling the machine with a motor for doing the effective work on the soil. This promises interesting developments, owing to the greater flexibility of animals in going over grades and soils of varying resistance. This is already accomplished in the United States in the case of harvesters, a growing percentage of which have small gasoline engines mounted thereon for running the cutting and binding parts. The use of electricity seems eliminated at present by the cost of transmission and the lack of storage batteries which will widen the electrical field motor's radius of action.

A hopeful phase of the situation for the small American farmer is that in France, where the need of a small motor capable of doing a great variety of work is most apparent, engineers have set themselves the task of analyzing and solving the fundamental problems presented. Economic conditions in the United States are not now such as to offer a sufficient reward for the working out of such mechanisms. It is a question, therefore, as to whether we shall be brought to this necessity in time to set our best inventive genius seriously at work upon the problem, before the greater necessity of solving it in France and other European countries shall have brought forth mechanism which it will only be necessary for us to transplant, at the proper time.

# The Physiology of the Dinner Table*

## Time Honored Customs Endorsed by the Findings of Science

By R. S. Levenson, M.D.

WHEN customs become so universal as have those of the civilized world in regard to the composition of the daily meal and the order of the various courses comprising it, they no longer excite our curiosity. Were one asked for the reason of our practises in the composition of the ordinary dinner he would probably state that custom has established the routine and would not for a moment think that there is good physiological reason for it. There nevertheless is. The discoveries in the physiology of digestion during the past dozen years have shown that there is scientific basis for our habits in the taking of food and that we have unconsciously established a routine of courses in the dinner that takes thorough cognizance of the physiological principles upon which digestion is founded.

In more elaborate affairs than the ordinary dinner there is seen to be on analysis a purposiveness in our practises that may on casual observation seem to be entirely without physiological significence. Take, for instance, the elaborate gowns worn by the women and the evening suits by the men, the floral decorations, and the music.

There is no doubt that each of these serves the function of composing a generally favorable stage-setting as it were for digestion. It has been abundantly shown in recent years that a person's mood is of the greatest significance in the performance of the digestive functions. If one is in a happy frame of mind, free from cares and worries of his professional or commercial surroundings, digestion proceeds as it normally should; on the other hand, worry, anger, and anxiety are potent factors in destroying the normal progress of the digestive functions. There can be but little doubt that such practises as we have mentioned tend to dispel any of these unfavorable moods that may be the relics of the care-laden day, and produce a frame of mind conducive to the normal progress of digestion.

Coming now to a consideration of the composition of the meal itself, think how frequently the first course consists of some article of food which appeals forcibly to our sense of smell, as caviar, sardellen, anchovies, or smoked salmon. This practice is of course in accord with the principles of digestion first thoroughly investigated by Parlow, who showed in his wonderful series of experiments that the most potent factors in the production of a favorable flow of gastric juice are stimuli which appeals to the various special senses, chiefly smell and taste. Moreover, the taste of these articles as well as others commonly employed as one of the introductory courses of a meal, such as oyster, lobster, clam, or crab cocktail, salads, and the various relishes, is such as to appeal forcibly to the sense of taste and thus produce an abundant flow of "psychical" gastric juice. The importance of the psychical influence of these articles of food will, I think, be at once appreciated by most individuals if they but think for a moment of such articles and note the ready flow of saliva which ensues. Though without any noteworthy amount of nutritive value, such foods are of great importance in digestion on account of their influence in inaugurating the flow of gastric juice.

The second course in the usual dinner menu is soup and here we again find substantial physiological reasons for its being placed where it is. Here also we are indebted to Parlow for the discovery of the fact that the only other stimulus to the flow of gastric juice besides the various appeals to the special senses, is a chemical one, and the most potent factors inducing this flow of chemical gastric juice are the meat extractives, which of course are the principle components of broths and soups. We thus see that there is a definite physiological reason for the introduction of broths and soups into the early stages of the meal.

The *entree* which usually follows the soup apparently serves the rather negative purpose of merely consuming time for the acid gastric juice to be secreted in sufficient quantities to be in readiness for reception of the next, and, from the gastric standpoint, the most important course of the meal, the meat course; so far as gastric digestion is concerned, proteids, as represented by meat, are the most important articles of the meal, and it is the digestion of these for which we may consider the previous gastric activity to have been in preparation.

Dessert is usually composed of entirely different food stuffs than are the earlier courses. Carbohydrate preparations of frozen foods composed chiefly of milk or cream, water, fruit flavors and sugar, compose the desserts usually found on the modern menu. Here again physiological research gives us an excellent reason for the placing of these articles at the end of the meal. Until within recent years the general medical as well as lay view of the stomach was a large hollow organ which by a vigorous churning movement mixed together all of the food stuffs introduced into it, and when this was sufficiently churned and mixed expelled it into the duodenum. To-day we know that this is quite incorrect. Instead of there being a general admixture of all the matter taken into the stomach there is a layer-like arrangement in which the material first introduced takes a peripheral position next to the gastric muscosa, that subsequently introduced taking a more and more central position. Only the material which lies next to the gastric mucous membrane is acted upon by the gastric juice; when the latter agent has sufficiently acidified and pepnotized this, the slow wavy peristalsis of the fundus moves this peripheral portion into the pyloric antrum and thus the next layer comes into contact with the mucosa.

According to this process, the food last taken into the stomach is thus placed most centrally and is in this way protected from the action of the acid gastric juice for as long as several hours. It is this fact which gives us the reason for the carbohydrate food stuffs being placed at the end of the meal. It is well known that the gastric secretions contain no ferments which act upon starch. Such a ferment, however, is contained in considerable quantities in the saliva, the so-called amylopsin. In the process of mastication and insalivation of the food the amylopsin comes into intimate contact with the food particles and, given favorable surroundings, is able to effect a considerable degree of starch digestion, for quite some time after the food leaves the mouth. This favorable surrounding the carbohydrate dessert finds in the central position that it takes in the stomach contents, where it is well protected from the action of the acid gastric juice which, as is well known, would immediately destroy the activity of amylopsin, which is able to act only in an alkaline medium.

We thus see that there is sound physiological reason for the arrangement of the meal as it is ordinarily composed in civilized countries and that almost each course and each article serves some function in harmony with the laws of digestion.

*Reproduced from the *California Medical and Surgical Reporter*

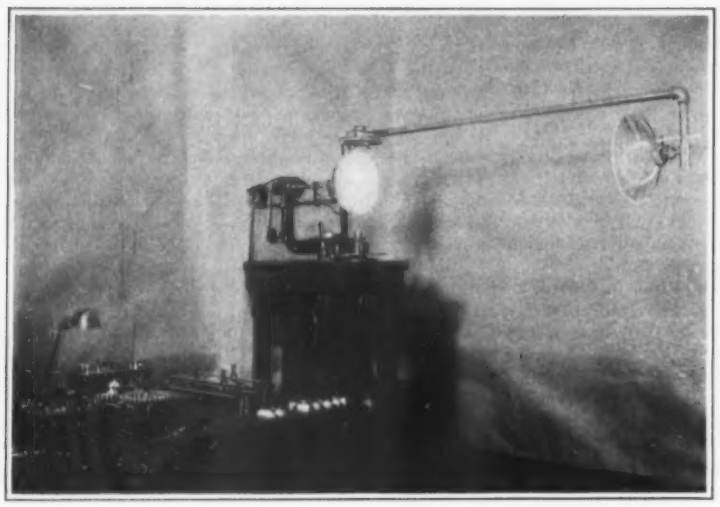


Fig. 1.—Apparatus for Making Measurements at Different Angles.

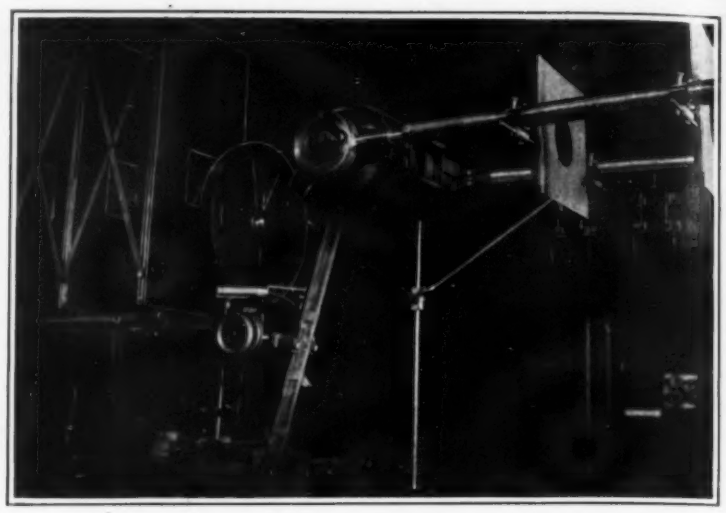


Fig. 2,—Near View of the Photometer Head and Screen.

# A Modern Photometric Equipment

## The Measurement of Luminosity in the Technical Laboratory

IN developing scientific illuminating appliances a most complete commercial photometric laboratory has been equipped at a works of one of our large manufacturing firms in Newark, Ohio. The accompanying illustrations, Figs. 1-4, show the modern instruments used in this laboratory, including a special switchboard and rectifier with apparatus for maintaining constant current as noted in photograph, Fig. 4, also a device for measuring the coefficient of reflection at different angles as indicated in Fig. 1. The photographs Figs. 2 and 3 show the photometric screen employed and the end of the photometer bench which illustrates the method of making direct angular readings.

For lamp and reflector testing, where the lamp must be in a pendent position, quite a large photometer is necessary. Four methods may be employed for this work. By the use of mirrors which rotate about the lamps to be tested, the test lamp and the photometer head may remain in a stationary position. This is an advantage because the apparatus to rotate the lamp may be made quite simple, but it has its drawbacks because of the difficulty in obtaining mirrors which are absolutely uniform and have no variation in the coefficient or reflection. Even though the mirrors may be uniform at first, they will deteriorate rapidly, and this deterioration is not uniform.

When a reflector is to be tested, the mirror is practically calibrated for the coefficient of reflection over a very small area equal to the image of the standard lamp, and this coefficient is assumed to apply for the whole mirror. Again, the mirror acts selectively in its absorption, absorbing certain colors more than others.

Another method requires the rotation of the photometer head about the lamp, but this means that the person reading the photometer must move in a circle about the lamp to be tested, and where a test distance of 10 feet is used, this would require a small Ferris wheel.

Still another method necessitates rotating the lamp about the photometer head. This requires a large beam or crane, the use of which is attended with numerous difficulties. Finally, a method may be employed in which the lamp is moved in a vertical line and the photometer head in a horizontal line. The apparatus for such testing is called a Dibdin radial photometer. This form of photometer was adopted at the works referred to above, as offering the least difficulties and sources of error.

To keep the photometer head at a fixed distance from the lamp to be tested, 10-foot connecting rods are used, fastened to the lamp carriage and to the photometer head. As the photometer head is fastened to a table which travels on a track in the floor, when the lamp carriage is raised, it moved the table along the track

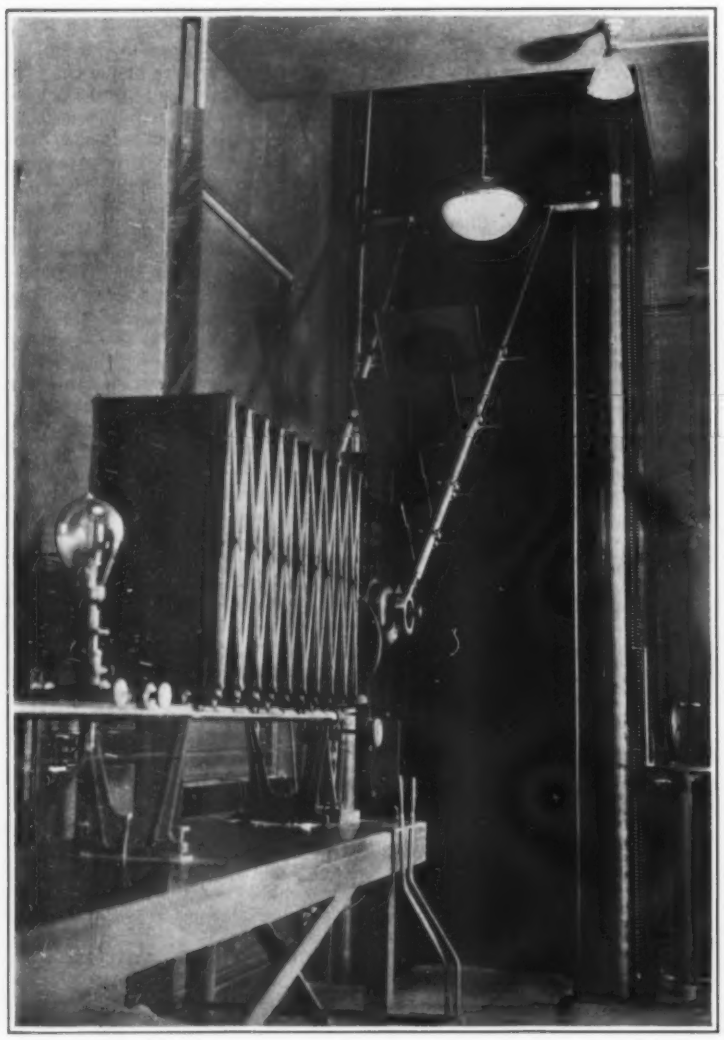


Fig. 3.—End View Showing Method of Taking Direct Angular Readings.

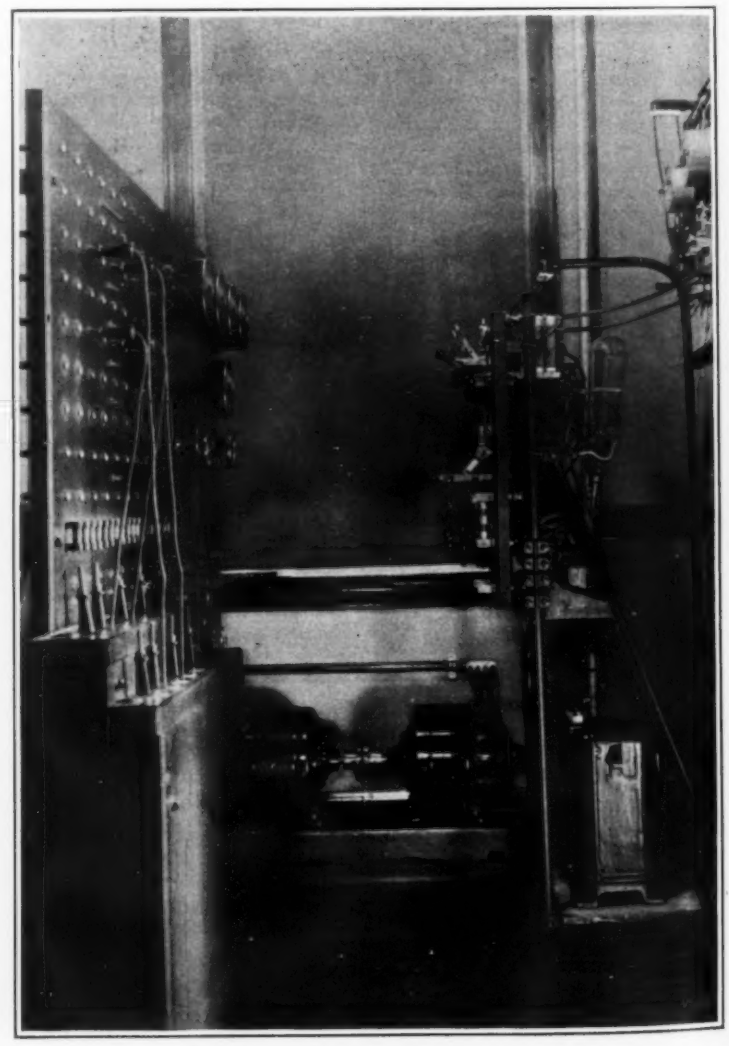


Fig. 4,—Switchboard and Rectifier.

toward the vertical line directly below the lamp. It is necessary that the photometer head should bisect the angle between the photometer screen, the test lamp and the comparison lamp, and a mechanical device is used which does this automatically. When it is desired to test a unit above the horizontal a trap door is opened in the floor and the unit is lowered into a pit in the basement.

One of the usual drawbacks to the Dibdin photometer is the screening system. This is more difficult to construct for this kind of photometer than for the usual bar photometer, because the light enters the photometer head at various angles. A special device was constructed which causes the opening on the test lamp side to revolve with the test lamp and keeps the opening on the comparison side stationary, as indicated in photograph Fig. 2.

A second common cause of error in the Dibdin photometer is in the method of setting the angles. If the angles are measured off on the vertical line it is impossible to make a correct setting at or near zero degrees—that is, in angles directly below the unit—inasmuch as an extremely small error in the setting along the vertical line means a larger error along the horizontal line.

If the angles are measured off on the horizontal line, it is impossible to make an exact setting at or near 90 degrees—that is, for measurements of candle-power near the horizontal. To avoid this difficulty holes are drilled in the track on the floor at distances to give the correct angles and a pin is dropped into these holes to give a correct setting for the photometer head end. The test lamp end is finally adjusted by means of a steel tape on which the angles are marked off.

By providing special holder devices it is possible to test with the lamp rotating or stationary and with the reflector rotating or stationary, to adjust the lamp so as to center the filament, to move the reflector up or down relative to the lamp, to test a combination of lamp and reflector inside of a two-piece sphere, to test lamps ranging from an incandescent lamp to a flaming arc lamp, to test upright and inverted gas burners.

There is a Brook's deflection potentiometer used for the measurements of voltage and current. The advantage of this type of instrument lies in the fact that it combines part of the great accuracy of a potentiometer with a part of the quick action of a voltmeter. On the other hand, if in certain tests the accuracy of a standard voltmeter were sufficient, this same accuracy may be obtained from the deflection potentiometer with a far less strain on the eyes in reading to the last place.

In case small units are tested and the lamps can be burned horizontally while rotating, the tests are run on a smaller photometer in which a horizontal spherical rotator is used. The photometer is set at a distance of 10 feet from the unit tested and rests on the end of an iron-framed carriage or stand. This carriage may be moved on a track which extends through the building, so that tests may be made at any distance, from a foot to 30 or 40 feet. An investigation is now being made to determine the effect which testing at various distances has upon the distribution curves.

There is a third photometer used in commercial testing, a standard voltmeter being used in connection with this instead of the deflection potentiometers which are used on the other photometers.

The second photometer, an apparatus, has been equipped for the measurement of the coefficient of reflection of surfaces such as wall papers, as indicated in photograph, Fig. 1. The material to be measured is fastened to a disk and the disk fastened to a universal rotator.

The disk is illuminated by a lamp and reflector at the end of a 4-foot arm, which is connected to the universal rotator. The arm may be turned through any angle relative to the disk and through any plane so that the incident light on the disk may be at any angle and the reflected light measured at any angle. Published figures on the coefficient of reflection of surfaces have usually been obtained by measuring the reflected light at a fixed angle or by measuring the distribution of light through a single plane perpendicular to the surface and containing the line of direction of incident light. Both of these methods are wrong unless the surfaces give perfect diffusion.

Using the apparatus just described, a more correct coefficient of reflection can be obtained by making tests in a number of planes. It is necessary that the incident light fall on the reflecting surface in a parallel beam in order that a fixed angle of incidence may be obtained. In order to do this a parabolic reflector is used and with it a high candle-power lamp having a very compact form of filament.

Lummer-Brodhun screens of the contrast type are used, and because of the very great range in candle-power in tests or reflectors, it is necessary to have long tracks for the comparison lamps, but in addition each photometer has a sector disk, which may be placed on the test lamp side or the comparison lamp side, and therefore the range is increased to a great extent.

One of the most useful adjuncts to a photometer is the sector disk. This photometric laboratory is equipped with special means shown in part in Fig. 4, for obtaining constant voltage of either alternating or direct current and of voltages covering the range of battery lamps to 250-volt lamps. Where life tests of lamps are made, an elaborate scheme of distribution is necessary, but where the current is supplied to photometers, only, as in this case, the charging and distributing apparatus is quite simple.

As seen in Fig. 4, a mercury arc rectifier on the right is used to charge the storage batteries, which are in a separate basement room directly below the switchboard room. The charging panel is shown on the left, toward the back, and the distributing panel arranged like a telephone switchboard, is shown in front. When it is desired to test an alternating-current lamp, the motor generator is operated from the storage batteries and a constant voltage is thus obtained on alternating current as well as on direct current for this service.

# Predicting Water Supply for the Farmer

## Forecasting Summer Flow of Streams from Snow Measurements in the Mountains

By J. Cecil Alter, Observer U. S. Weather Bureau, Salt Lake City, Utah

THE irrigation farmer would like to know by the close of February each year how much snow lies in the mountains to feed his irrigation streams so that he can select his crops and make his summer plans accordingly.

The crest between Right Hand Fork and Dibble Fork. This drift of snow was blown from the west (right) over the sharp comb. The only drift on the water shed. Elevation about 9,000 feet; 15 to 25 feet deep; 1 mile long.

If there is to be a shortage of water it may be possible for him to select a crop requiring less water, or one that will mature earlier; or, probably, he can fallow a certain field to advantage that is in need of a rest. On the other hand, if there is to be an abundance of water, he may be able to select a much desired crop that requires a great deal of moisture, one that he cannot often handle because of his having too little irrigation water; perhaps he can put out a crop that matures late in the fall, or can include some distant land under the water for use in the season of abundance.

The hydroelectric power companies are also very much interested in the probable stream flow, as a deficiency of water may mean that part of their machinery must lie idle, and that a contract for light or power cannot be met. The foreknowledge of an excessive flow of water through the turbines makes possible the execution of bigger contracts for service, and perhaps at a much better rate.

A flow forecast, even if it contain the bad news of a great shortage, is sure to mean that both the farmer

A measurement among the Quaking Aspen trees. Depth 38.4 inches; water equivalent on scale, 13.2 inches; or 34 per cent water.

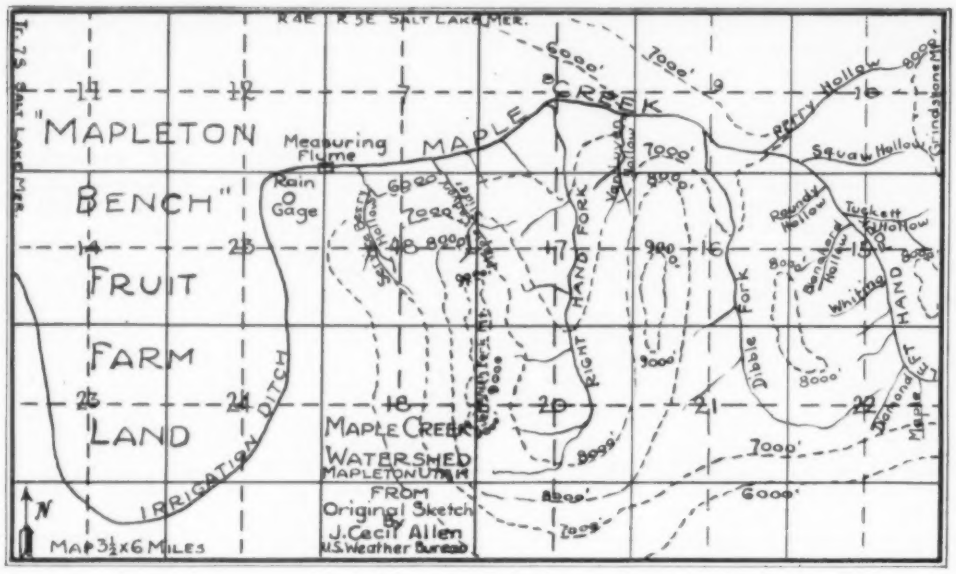
and the power company will make more money than they would have made without this information, and thus the entire community is benefited an incalculable amount by a stream flow forecast.

Without this prediction the water user can only make his plans as if he were to have a normal flow of water, and to take his chances with the occasional deficiency or excess.

Since the question of snow supply is always a vital one to him, he usually makes inquiry of mountain travelers and hunters regarding the snow deposits and the water prospects, and he sometimes makes a reconnoitering trip, himself, over his supply streams before plowing time, but he has never made any attempt to get exact and systematic measurements of the snow for comparisons with other years so that his estimates could be stated in figures.

The primary water users, who have first rights during times of deficient water, do not care whether there is much or little, as long as they have enough; but some of the secondary users may go through an entire season without an inch of water. A systematic survey

The density apparatus. A sampling tube 2½ inches diameter and 50 inches long; a spring balance scale for weighing the tube and contents hanging from the alpenstock. First outfit ever used by Weather Bureau. Scale graduated to read the water equivalent of contents of snow tube.



of the snow deposits on the watershed would be of equal benefit to all since the primary water rights may suffer at times. All are about equally interested in knowing approximately what the stream flow is likely to be. Thus it becomes everybody's business, and, consequently, nobody's business.

It is for this reason that our Uncle Samuel has taken up the work in an experimental way, and the practicability of the scheme, so far as perfected, seems to warrant the expectation that the snow will be measured and the stream flow predicted very closely early each spring, in the not distant future, for every irrigation district in the West where such a work is desirable. In the language of James Wilson, the Secretary of Agriculture, "The work can be extended to other and larger projects, and will be limited only by the amount of funds available for the work. The preliminary campaign has received the hearty commendation of farmers and engineers."

The present winter reviewed the need for such information, and presented what has been partially proven to be a successful method of obtaining the snow measurements and making the forecast, in the spring of 1910. The suggestion was made that the United States Weather Bureau seek out those lateral streams whose flow is limited when compared with the possibility of its use; streams whose water, if plentiful, will irrigate many more acres and grow additional crops of alfalfa on the same acreage; or if scanty, will greatly diminish the acreage tilled, decrease the number of hay crops, and affect the quality and quantity of other crops.

As is well known, the large normal flow of many mountain streams, and the limited utilization of the flow of many others, make a flow forecast of much less value in these cases. Therefore it is only on the streams where there is a possibility of a detrimental shortage, or an advantageous surplus, that a flow forecast is worth paying something for.

The problem presented was to make a systematic survey of the extent, depth and density of the snow, and determine approximately the number of acre-feet of water, in the form of snow, lying on the watershed slopes in the spring. By observing the stream flow thereafter at a gaging station located above the highest canal, some estimate could be made of the water remaining in the mountains in the form of snow at any time during the progress of the season.

It was also necessary to determine the amounts of expansion and contraction of the irrigated area with the variation of the water supply, and to compare this with the cost of the survey to determine its practicability in any special case. The date of the survey must be prior to the selection of the crops, to be of value, yet the problem of the survey grows simpler as the snow supply decreases and solidifies with the advance of spring. Theoretically the measurements should be made simultaneously throughout the watershed, just after the spring rains and warmth have taken away the late snows and produced the spring flood or runoff; but to be most useful, the knowledge must be had when farmed areas are being determined, therefore the time of measurement seems to adjust itself to late February or early March in the Wasatch Mountains.

Evaporation loss from the watershed after the measurement of the snow may be estimated from known laws with even greater accuracy than the rest of the system can be carried out. The precipitation occurring over the watershed after the completion of the survey must be measured by ordinary rain gages. The amounts of precipitation and evaporation should be applied as a correction to the stream flow readings in making any determinations as to the amount of snow remaining at any given time.

The watershed chosen for the first systematic snow survey was Maple Creek, a small stream which waters 227 tracts of highly productive fruit and farm land on Mapleton Bench, near Springville, Utah, and about forty-five miles southeast of Salt Lake City. This selection was made by Mr. A. H. Thiessen, in charge of the Salt Lake City office of the United States Weather Bureau, acting under the general supervision of Dr. H. C. Frankenfield, Chief of the River and Flood Division of the United States Weather Bureau in Washington. The actual work of the survey was done by the present writer and an assistant.

The entire region was mapped with as fair a degree of accuracy as seemed necessary for the purpose of locating the various canyon branches of the watershed, and of showing the exact location of all the tracts of irrigated land on the Bench, with the names and addresses of the owners.

The actual work of the snow survey consisted in going up the bottom of each gulch or canyon and back and forth along the slopes, measuring the snow depth and density every thousand feet or so, depending upon the variability of the snow deposit, the general topography and the brush or forest cover, and mapping the snow area on a field map.

According to the completed map, there are about 6,880 acres in the watershed, about 4,000 of which were covered with snow at the time of measurement (last week in March, 1911). About 2,000 soundings for depth were made with a graduated alpenstock searching for average places, and 277 measurements of the depth and density were made in carefully selected, representative places with a snow density apparatus which was devised and perfected for the purpose by Prof. Charles F. Marvin, Chief of the Instrument Division of the United States Weather Bureau. This is an average of one density measurement to each 14½ acres of snow.

The average of the 277 depth measurements was 36 inches, and the water equivalent, shown by the sampling tube and the weighing scales (the density apparatus) was 11.5 inches, or 31.9 per cent water, making 3,800 acre-feet of water, or enough to spread 14 inches deep over the 3,250 acres of land reached by Maple water.

The object in making each measurement was to get values that were typical or representative for regions several acres in extent which would, by reason of their exposure, be comparable from year to year; also which could be located in the future from field notes.

Complete notes concerning the snow itself were kept to make comparisons easier with surveys in subsequent years. For instance, the *résumé* of the record for Maple Canyon Slide, one of a dozen branches, reads: "This region presents an abrupt slope up to the south, averaging from 35 degrees to 40 degrees, yet it carries a very even deposit of snow. The lower half, on both sides of the broad ravine, was bare, or carried but a trace of snow. Higher up among the scattering pines and quaking aspen trees, from about the 7,000-foot elevation contour to the summit, the average of thirty-four representative measurements, made at places located as shown on the field map, was 37 inches in depth, with a water equivalent of 11.4 inches, or 30.8 per cent."

A detailed report of this kind for every lateral in the watershed, with a general synopsis, was printed promptly after the completion of the survey, and mailed to every land owner using Maple water. The names of the hollows, forks, and canyons used in the report are the names by which they are commonly known by the residents of Mapleton Bench.

Stream flow measurements at a weir, located some distance above the highest farm land, have been made daily since the completion of the survey, and will be continued throughout this year (1912) and probably indefinitely in the future. Rain and snowfall observations have also been made from a precipitation gage located near the weir, and are to be continued indefinitely.

The first year's records of runoff, following the survey, are not directly comparable with the amount of water in the form of snow, shown by the survey, even when corrected for precipitation gain, and evaporation loss, as there is a seepage loss in this particular canyon, the amount of which cannot be determined from one year's observations. As a matter of fact, the limit of accuracy of the relation of the flow of any stream to the amount of water calculated from the snow measurements cannot be determined in less than three or four years so that comparisions may be made of one year with another.

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**Heat and Energy Consumption of the Human Body.**—On an average a man dissipates about 2.5 kilowatt hours per day. This is spent partly in muscular action, partly in the production of heat in the maintenance of the body temperature against radiation. There is thus a continual power consumption of about 100 watts, or one-seventh of a horse-power. About one half or this is spent in maintaining the body temperature. The human body has about the same heating effect upon the surroundings as a 16 candle-power carbon filament lamp.

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